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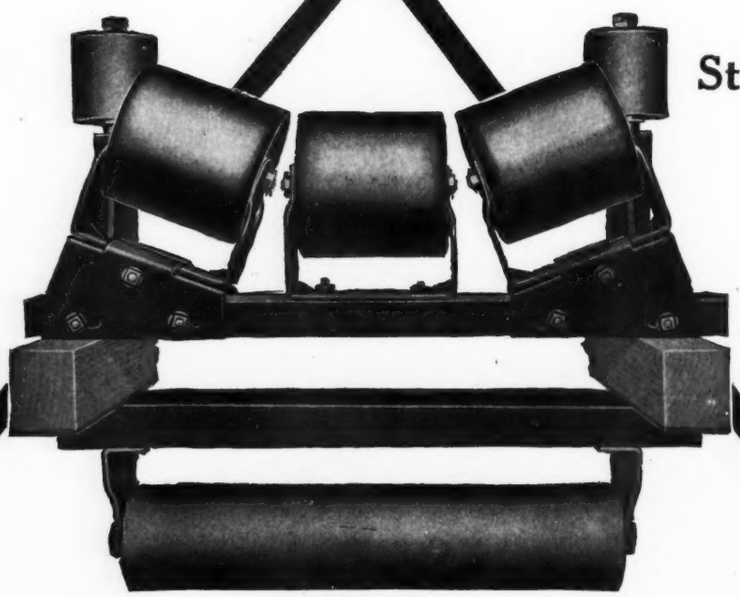

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Engineering and Mining Journal

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Santa Gertrudis Mill, Pachuca*

SYNOPSIS—A description of the Santa Gertrudis mill, one of the best of cyanide plants of the modern all-sliming type. The plant will handle 1,100 tons per day, and cost $792 per ton of daily capacity.

The milling operations of Santa Gertrudis at Pachuca, Mexico, are carried on by a separate organization, known as Cia. Beneficiadora de Pachuca, S. A. The plant capacity is 1,100 tons per day. The accompanying flow sheet shows the arrangement of the machinery. The crushing-plant bins—of 600 tons capacity—feed two No. 6K gyratory crushers, discharging to a double screen 14 ft. long; the oversize from the 4-in. round-hole screen passing by conveyor to the tube-mill storage bin, the undersize joining the oversize of the 2-in. round-hole screen for crushing in two No. 4K gyratory crushers; the undersize from the 2-in. screen, together with the discharge from the secondary crushers, is delivered to a 22-in. troughed belt conveyor equipped with Merrick Weightometer. The 22-in. conveyor discharges over the first one of three Vezin samplers, a 5% cut being taken and stored in a sample bin of 15 tons capacity; the reject flows to a 30-in., shuttle-type, flat-belt conveyor for distribution into battery bins of 2,000 tons capacity. The first sample cut is fed from the 15-ton bin through a set of 26x15-in. rolls reducing to ¾ in. and finer and discharging to a second Vezin sampler cutting out 10%, which is delivered by a revolving Challenge feeder to the third Vezin, taking a 20% cut. The sample thus obtained is one ton for each 1,000 tons milled and is crushed to ¼ in. in a size F gyratory crusher, thereafter being cut down by Jones riffles and reduced in the usual manner. Rejects from the second and third Vezin samplers and from the quartering floor are returned to the battery bins by an 8-in. elevator.

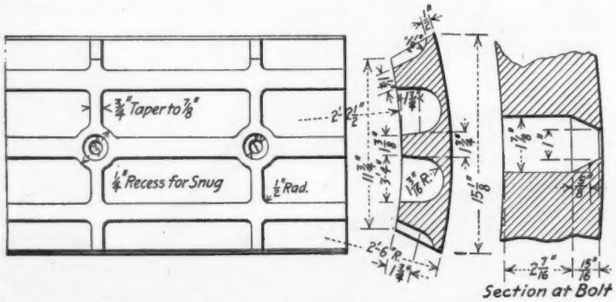
The ore passes from the battery bins through Hoscur feeders to sixty 1,550-lb. stamps arranged in units of 10 stamps each, 20 stamps being driven by a 65-hp. motor belted to a jackshaft; the stamps make 102 7½-in. drops per minute; 3-mesh and 4-mesh screens are used, the pulp from the batteries flowing through split distributing launders to six primary duplex Dorr classifiers, the sand passing to six 5x16-ft. tube mills, the discharges from which are delivered to the launder, going to the secondary classifiers by elevator or by reserve 10x54-in. Frenier pumps, one pump to each mill. The slimes overflow from the primary classifiers is laundered to 8 secondary duplex classifiers, feeding sand to four 5x20-ft. and two 5x22-ft. tube mills, the discharges from which are returned by elevator or Frenier pumps to the classifiers. The slimes overflow from the secondary classifiers passes to 6 primary

GENERAL VIEW OF THE SURFACE PLANT OF THE SANTA GERTRUDIS AT PACHUCA, MEXICO

*Excerpt from an article by Hugh Rose, in the "Bulletin" of the American Institute of Mining Engineers. August, 1916.

Dorr thickening tanks, 35 ft. diameter by 15 ft. deep, wherein the pulp is thickened from 10 to 1 to 1.5 to 1. The thickened pulp is delivered to a set of 14 primary Pachuca tanks, 15x45 ft., operating in series; the discharge from the last tank in the series is by means of an air lift submerged in the tank itself and delivering to a launder, where a wash of four parts of mill solution is applied, the pulp flowing to four secondary Dorr thickening tanks, 35x15 ft., wherein it is again thickened to about 1.75 to 1 and delivered to a set of 14 secondary Pachuca tanks, 15x45 ft., also operating in series, the discharge from the last tank of the series flowing to two 35x12-ft. storage tanks equipped with mechanical agitators.

These storage tanks feed by gravity at 35 lb. pressure four 90-frame Merrill filter presses, size of leaf, 4x6 ft., width of frame 3 in. The tailings sluiced from these presses flow to four 35x15-ft. Dorr thickening tanks for recovery of water before passing to the tailings-storage dams. The pregnant solution is clarified by passing through four sand-filter tanks, 40 ft. diameter by 10 ft. deep. Precipitation is effected by the Merrill zinc-dust process in two circuits, partial and barren, in order to economize in zinc dust; two presses are in use on the barren circuit and three on the partial. The precipitate is melted in a battery of 8 oil-fired, No. 400 crucible



SANTA GERTRUDIS TUBE-MILL LINING

furnaces arranged on the arc of a circle and served by a radial jib crane fitted with an air cylinder for raising and lowering the pots.

All pumping of solution and water is concentrated in two pumphouses, one below the filter plant and the other below the precipitation plant. The pumps are of vertical triplex-plunger types, gear-driven by motors, and are installed so that one pump is in reserve for two circuits. An electrically operated inclined tramway runs from the top to the bottom of the mill, delivering material to any floor.

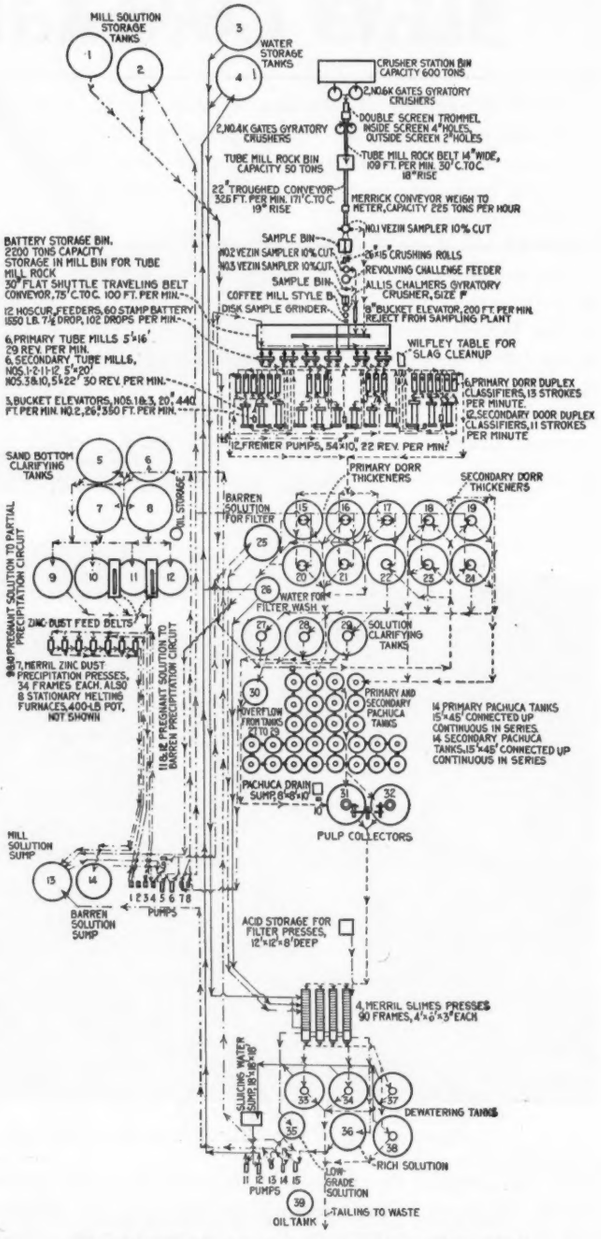
Details of Construction and Operation

Compactness of design was sacrificed to secure a gravity flow. Such design was permissible owing to an unusually ample mill site of 17° slope, coupled with a mild climate requiring no housing of tanks. Supervision is made easy because the size of the plants warrants the division in two departments, mill and cyanide, and the tramway is used by the bosses in getting round. The mill is electrically driven throughout, 50-cycle alternating current being distributed at 440 volts.

The crushing-plant design exhibits no points of special interest. The elimination of elevator returns and the favorable character of the ore make the operation unusually easy and simple. Consumption of steel liners, etc., is almost negligible. The 6K gyratory crushers, driven by 30-hp. motors, take only 15 hp. each. This is again due to the character of the ore and the large percentage of fines, which, if the ore had greater abrasive quality, it might pay to screen out beforehand.

An ample supply of mine rock over 4 in. in size, for use in the tube mills in place of pebbles, is obtained cheaply from the revolving-screen oversize.

Particular attention is paid to securing an accurate sample of the ore delivered to the mill. Ordinarily two


MILL SOLUTION STORAGE TANKS
WATER STORAGE TANKS
CRUSHER STATION BIN CAPACITY 600 TONS
2,NO.6K GATES GYRATORY CRUSHERS
2,NO.4K GATES GYRATORY CRUSHERS
DOUBLE SCREEN TROMMEL INSIDE SCREEN 4" HOLES, OUTSIDE SCREEN 2" HOLES
TUBE MILL ROCK BIN CAPACITY 50 TONS
TUBE MILL ROCK BELT 14" WIDE, 109 FT. PER MIN. 30° C. TO C. 18" RISE
22" TROUGHED CONVEYOR 326 FT. PER MIN. 171° C. TO C. 19" RISE
MERRICK CONVEYOR WEIGH TO METER, CAPACITY 225 TONS PER HOUR
NO.1 VEZIN SAMPLER 10% CUT
SAMPLE BIN
NO.2 VEZIN SAMPLER 10% CUT
NO.3 VEZIN SAMPLER 10% CUT
5"x15" CRUSHING ROLLS
REVOLVING CHALLENGE FEEDER
SAMPLE BIN
ALLIS CHALMERS GYRATORY CRUSHER, SIZE F
COFFEE MILL STYLE B
DISK SAMPLE GRINDER
18" BUCKET ELEVATOR, 200 FT. PER MIN. REJECT FROM SAMPLING PLANT
BATTERY STORAGE BIN, 2200 TONS CAPACITY STORAGE IN MILL BIN FOR TUBE MILL ROCK
30" FLAT SHUTTLE TRAVELING BELT CONVEYOR, 715' C. TO C. 100 FT. PER MIN.
12 HOSCUR FEEDERS, 60 STAMP BATTERY 1550 LB. 7½ DROP, 102 DROPS PER MIN.
WILFLEY TABLE FOR SLAG CLEANUP
6 PRIMARY TUBE MILLS 5'x16' 29 REV. PER MIN.
6 SECONDARY TUBE MILLS, NOS. 1-2-11-12, 5'x20' NOS. 5-8-10, 5'x22' 30 REV. PER MIN.
16 PRIMARY DORR DUPLEX CLASSIFIERS, 13 STROKES PER MINUTE.
12 SECONDARY DORR DUPLEX CLASSIFIERS, 11 STROKES PER MINUTE
5 BUCKET ELEVATORS, NOS. 1-3, 20' 440 FT. PER MIN. NO. 2, 26' 360 FT. PER MIN.
12 FRENIER PUMPS, 5x4x10, 22 REV. PER MIN.
SAND BOTTOM CLARIFYING TANKS
PRIMARY DORR THICKENERS
SECONDARY DORR THICKENERS
OIL STORAGE
BARREN SOLUTION FOR FILTER
WATER FOR FILTER WASH
ZINC DUST FEED BELTS
SOLUTION CLARIFYING TANKS
880 PREGNANT SOLUTION TO PARTIAL PRECIPITATION CIRCUIT
7 MERRIL ZINC DUST PRECIPITATION PRESSES, 34 FRAMES EACH. ALSO 8 STATIONARY MELTING FURNACES, 400-LB POT, NOT SHOWN
1180 PREGNANT SOLUTION TO BARREN PRECIPITATION CIRCUIT
OVERFLOW FROM TANKS #1 TO 13
PRIMARY AND SECONDARY PACHUCA TANKS
14 PRIMARY PACHUCA TANKS 15'x45' CONNECTED UP CONTINUOUS IN SERIES. 14 SECONDARY PACHUCA TANKS, 15'x45' CONNECTED UP CONTINUOUS IN SERIES
PACHUCA DRAIN SUMP, 8'x8'x12'
PULP COLLECTORS
MILL SOLUTION SUMP
BARREN SOLUTION SUMP
1 2 3 4 5 6 7 8 PUMPS
ACID STORAGE FOR FILTER PRESSES, 12'x12'x8' DEEP
4 MERRIL SLIMES PRESSES 90 FRAMES, 4'x6'x3" EACH
SLUICING WATER SUMP, 18'x18'x8'
DEWATERING TANKS
RICH SOLUTION
11 12 13 14 15 PUMPS
LOW-GRADE SOLUTION
OIL TANK
TAILINGS TO WASTE

FLOW SHEET OF SANTA GERTRUDIS MILL

classes of ore are sampled separately each day. The rejects from these two are thoroughly mixed and quartered down, to make the mixture sample for the day. The calculated average assay of the two class samples checks very closely the assay results of the mixture. The usual samples are taken for moisture, which averages about 5%.

The design of the stamp battery follows standard lines except in a few minor details. The mortar-box foundation bolts are crossed, thereby permitting a broken bolt

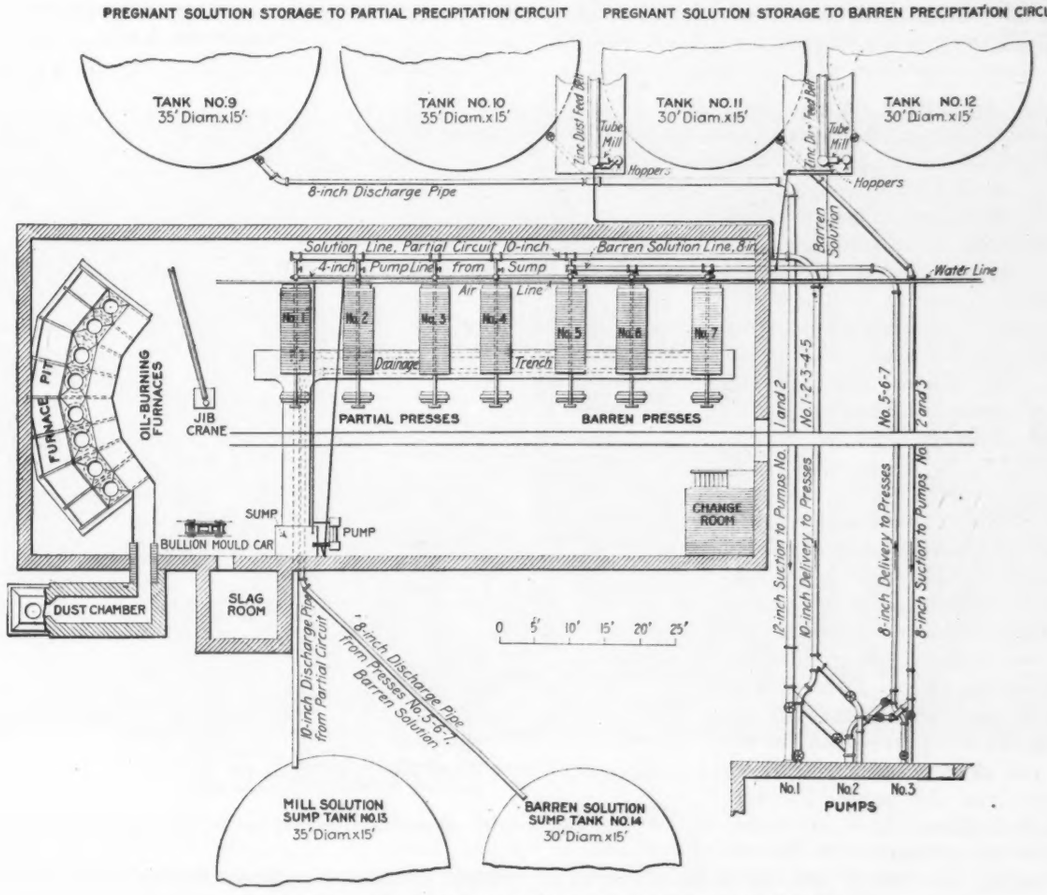
to be removed easily; none has broken thus far. A traveling crane, as well as a crawl, installed with the building, was found very useful in erecting the battery and in making subsequent current repairs.

The stamp duty averages 21.1 tons through 3-mesh and 4-mesh screens. Crushing is in mill solution, 10 parts of solution to one of ore. Screen wear is of no importance. Steel wear per ton is: Shoes, 0.16 lb.; dies, 0.08 lb.; liners, 0.60 lb. Life of shoes 9¼ in. diameter by 14 in. long averages 90 days; dies, 97 days; liners, 43 days. Shoes and dies are forged steel. Liners are cast iron, made locally; manganese-steel liners have been tried, but the cost per ton crushed was higher. The 65-hp. motors, each driving 20 stamps, are overloaded about 8%.

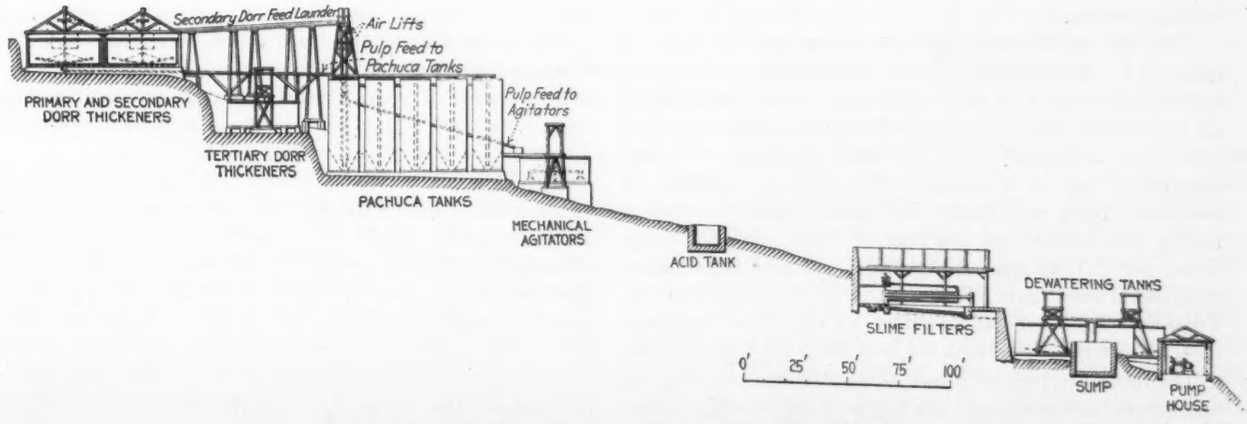
A trial was made of introducing the battery solution through nozzles in the back of the mortar box above the dies, but without success. Stationary screens placed between the feeder and the mortar box to take out fines were also tried and abandoned, the benefit gained being doubtful, while requiring more supervision.

Distribution of the pulp from the battery to the primary classifiers by means of split launders could be improved upon by a mechanical distributer of one of the successful revolving types.

The classifier platforms were built on an incline to save headroom over the tube-mill gears as well as to follow the slant of the classifiers. Returns to the classifiers from the tube mills are by elevators, with individual Frenier



PLAN OF PRECIPITATING AND REFINING DEPARTMENTS



TREATMENT SECTION OF THE SANTA GERTRUDIS MILL

pumps as reserves. A better design would be to effect such returns by means of the classifiers themselves.

Average screen analysis of feed and discharge of the stamp battery, equipped with 3-mesh No. 32 wire screens, is as shown in the table.

AVERAGE ANALYSIS OF FEED AND DISCHARGE

	Feed, %	Discharge, %
On 2-in.	0.5	....
On 1-in.	18.4	....
On ½-in.	13.8	....
On ¼-in.	8.0	....
On 4-mesh	18.7	4.0
On 8-mesh	11.5	16.3
On 10-mesh	1.8	7.5
On 20-mesh	8.5	14.8
On 30-mesh	3.9	8.1
On 40-mesh	1.4	4.4
On 60-mesh	2.2	6.7
On 80-mesh	2.0	6.2
On 100-mesh	0.5	2.7
On 120-mesh	0.8	3.2
On 150-mesh	0.4	1.7
On 200-mesh	0.2	2.7
Through 200-mesh	6.9	21.2
	99.5	99.5

Tube-mill grinding is done in two stages, using 5-ft. diameter mills throughout, the primary series being 16 ft. long and the secondary series 20 ft. and 22 ft. Comparison of this system with single-stage grinding has failed to show conclusive results in its favor. A slight benefit is apparent, but insufficient to warrant a repetition of this refinement of design unless in conjunction with water concentration not required with this ore. Danish flint pebbles were used for a considerable period, but their increasing cost led to the adoption of mine rock entirely to replace the pebbles. The mine-rock supply is obtained mechanically in the crushing plant and is sent separately over the regular conveyors to a compartment in the battery bin, from which it is transferred by chute to the primary tube-mill floor, where it is distributed by car. Part of the rock is introduced into the mill through the feeder. As the trunnion opening of the mills is not as large as it should be, rocks over 5 in. size as well as occasional large boulders, 12 in. to 15 in., required in the primary mills for efficient grinding, are loaded into the mills through the manholes once a day; 130 lb. of mine rock is required for each ton of ore milled and is credited to the total tonnage treated.

Tests are now in hand using cast-iron balls in place of mine rock. Results thus far obtained indicate a capacity increase of 33% with finer grinding. Power load shows an increase of 33%, from 65 to 90 hp. per mill. Forged-steel balls ordinarily used for such grinding were not obtainable, but it is probable that chilled cast-iron or semi-steel balls and liners will prove more economical taking into account the low cost of locally made castings (2.5c. per lb.), as against high first cost plus importation expenses of steel balls. Ball wear is 1.7 lb. per ton milled. Tube-mill liners are of modified El Oro type hard cast iron, the average life being six months; cost 2.2c. per ton.

The motor driving each mill through a flexible coupling and one reduction of spur gearing is of high-torque induction type, 65 hp. 230 r.p.m. Allis-Chalmers make, and its ample design easily carries the overload. But the power factor of this motor is low (75%) and an improvement would be to use a higher-speed motor with a single reduction of herringbone gearing.

The economical grinding point is taken at 75% through 200-mesh. The table shows screen tests of feed and discharge of primary and secondary tube mills, using mine rock and at a plant capacity of 1,000 tons daily. These data are worthy of careful consideration.

An extraction of 55.5% of the gold and 18.6% of the silver takes place in the mill before the pulp reaches the Pachuca tanks. Cyanide of sodium, 128 or 120% as obtainable, either in lump or brick form, is added at the first tank of the primary series, at the rate of 4 grams of sodium cyanide for each gram of silver in the ore delivered to the mill. The sodium cyanide consumed is 3.15 lb. per ton, including mechanical loss. The strength of solution at the beginning of agitation is 0.55% KCN; of the mill solution, 0.4%.

FEED AND DISCHARGE OF PRIMARY AND SECONDARY TUBE MILLS

Mesh	Primary Feed, %	Tube-Mills Discharge, %	Secondary Feed, %	Tube-Mills Discharge, %
On 4	13.9	0.2	0.8	1.6
On 8	22.8	4.5	0.5	0.1
On 10	8.6	2.2	0.4	0.2
On 20	20.6	8.5	1.6	0.2
On 30	11.8	10.9	3.4	0.7
On 40	4.7	4.8	3.3	1.0
On 60	8.0	12.1	17.5	10.8
On 80	1.9	10.2	9.6	5.6
On 100	1.6	5.2	11.4	10.3
On 120	1.5	6.5	17.6	15.5
On 150	0.7	4.0	9.5	11.8
On 200	0.8	5.7	8.4	11.2
Through 200	2.5	25.0	15.6	30.7
	99.4	99.8	99.6	99.7

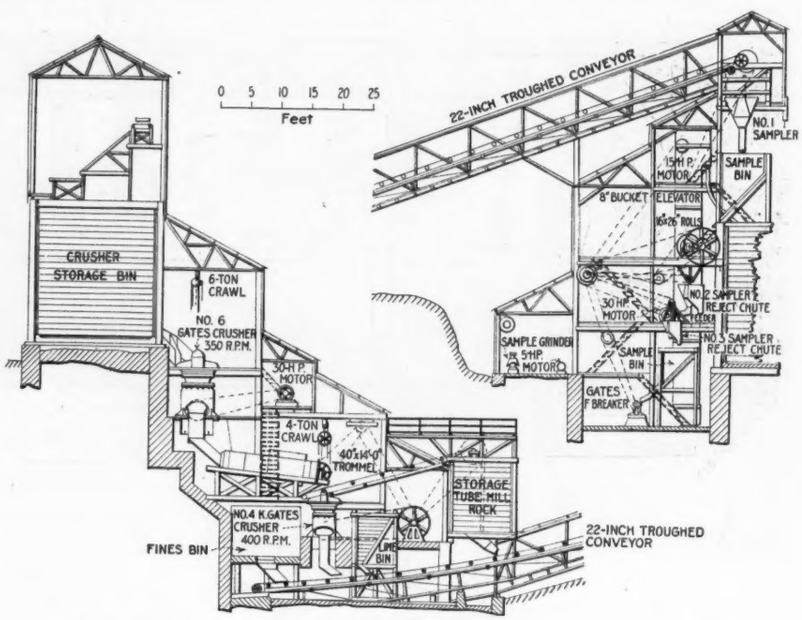
Moisture, 35 to 40%. Operating without return, 175 tons of ore pass through tube mill per 24 hr.

Moisture 35 to 40%. Operating with return, in closed circuit, 200 tons of ore pass through mill per 24 hr.

SECONDARY CLASSIFIER OVERFLOW

(Finished Product of Mill)

Mesh	Per Cent.
On 100	3.8
On 120	5.7
On 150	5.5
On 200	9.5
Through 200	75.1
	99.6



BREAKING AND SAMPLING PLANT OF SANTA GERTRUDIS MILL

Protective alkalinity is maintained about 0.75%; the lime is fed dry into the ore at the crushing plant; it is low-grade, averaging about 65% available, the consumption being 20 lb. per ton. Arrangements are in hand to improve the method of feeding by emulsifying the lime, adding it either to the primary tube mills or to the Pachuca tanks. Crude litharge, between 85 and 90% PbO, adopted in place of lead acetate as both cheaper and more efficient, is ground in a small tube mill, 24 in. diameter by 37 in. long, discharging into the first Pachuca tank at the rate of 0.6 lb. per ton of ore.

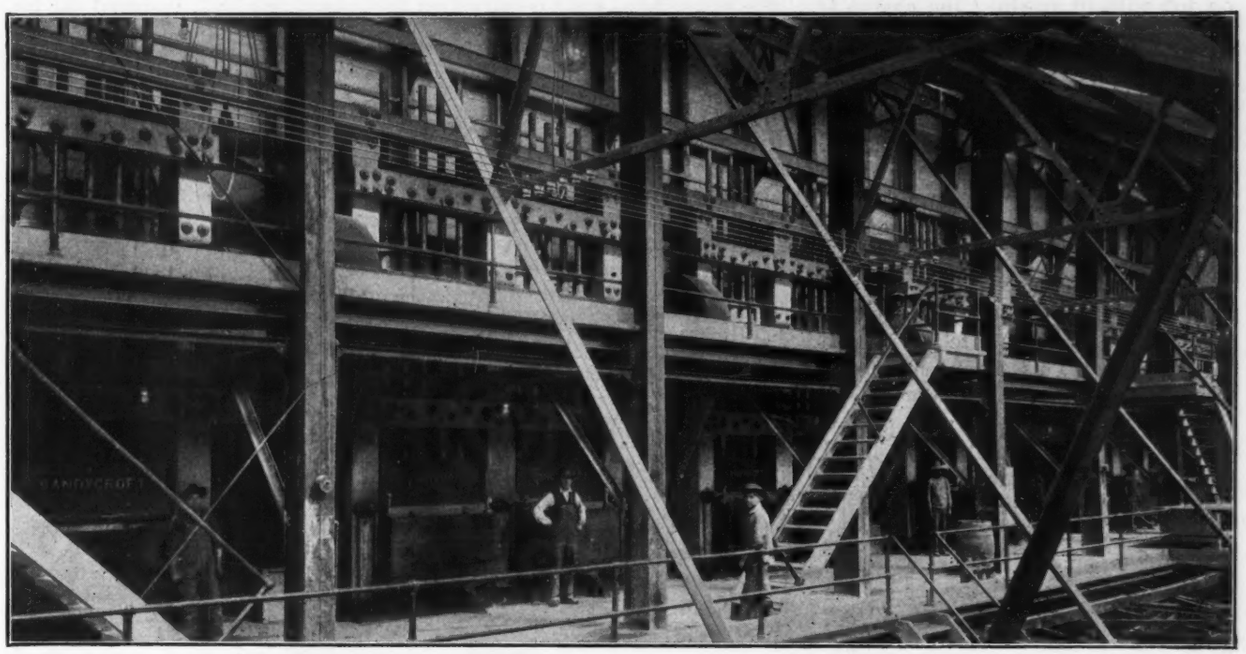
The best results are obtained with 72-hr. agitation, although 60 hr. give within 2% as high extraction. The air pressure is 27 lb., 75 cu.ft. per min. being required for each tank. No difficulty has been experienced with the series operation of the Pachuca tanks. Connections between tanks are made by 10-in. horizontal pipes placed 3 ft. from the top, the joint between two abutting pipes being made tight by a wrapping of tarred canvas. This joint takes up the tank vibration. To avoid undue accumulation of slimes on the inside of the tanks, they are emptied and sluiced down once a month. This operation requires about 3 hr. per tank, using a 3-in. Traylor slime pump for the return.

Screen tests of the inflow and outflow of the system are practically identical, showing that there is no segregation or short-circuiting of sand or slime.

The Procedure of Filtering

Filtering is difficult owing to fine-grinding of ore containing a considerable amount of colloidal matter. Also the dissolved values in the pulp to the filters are high—3.5 oz. silver per ton of solution. After extended working-scale tests of several types of vacuum and pressure filters, Merrill presses were adopted, using the center system of filling. A press cycle occupies 75 min., made up of: Charging, 26 min.; barren solution wash, 13 min.; water wash, 13 min.; sluicing, 23 min.; a total of 75 min. Bristol recording pressure gages are attached to the filling pipe of each press, the cycle curves from the chart giving an excellent check upon the care taken by the attendants in operating the presses. The sluice-valve bar and the filling valves are electrically connected so that both cannot be coincidently opened without ringing an alarm bell. The cakes average 1¼ in. in thickness, thereby leaving ½-in. space in the center of the 3-in. frame for entrance of washes. The presses handle 14.5 tons dry pulp per cycle. Sluicing water is at 90 lb. pressure, and five parts are required to clean out a press. The bulk of this water is recovered in dewatering tanks. No. 6 cotton duck 72 in. wide is used regularly, after several other weights had been tried. A set of cloths lasts about 2,500 cycles. Acid washing to remove lime is done in the press every 10 days, using 0.75% sulphuric-acid.

Much care is taken with the nozzles of the sluice bar. The bar of each press is taken out and tested every 48 hr., any defective nozzles being replaced. Nozzles are ordinary ½-in. cast-iron plugs, drilled $\frac{3}{16}$-in. hole; these last as long as special steel nozzles and are much cheaper. The unwashed metals in the press discharge average a trace of gold and 0.08 oz. silver, an efficiency of 97.7%.



BATTERY FLOOR OF THE SANTA GERTRUDIS MILL

All solutions to be precipitated are first passed through ordinary sand filter tanks. The addition of about 40% by volume of sawdust to the sand considerably improves the clarifying efficiency of the filtering medium and at the same time reduces the frequency of slime skimming and sand cleaning. The latter operation is effected by shoveling the sand from the tank to a launder leading to a small trommel, where the sand is washed free of slime with small loss and returned for use again. About 4,500 tons of solution is filtered daily at a cost of 0.28c. per ton solution. Possibly Merrill clarifying presses would be an improvement, although no comparative figures are available. At least the existing equipment does the work efficiently and cheaply, with little supervision.

The Merrill zinc-dust process of precipitation has in every way justified its adoption. The solution from the sand filters averages 0.015 oz. gold and 3 oz. silver. Two

circuits are maintained, one precipitating to barren solution sufficient for filter-press washing, and the other circuit to an effluent containing from 0.9 to 1.2 oz. silver per ton. To accomplish this a slight excess of zinc dust is fed to the barren circuit in the proportion of 1.1 oz. zinc dust to 1 oz. fine bullion; to the partial circuit 0.8 to 1. The average zinc consumption of the plant is 1 oz. to 1 fine bullion. Clean-up made at the middle and end of one month and sometimes oftener provides an accurate check on current work.

The only drying given the precipitate is by blowing air through the presses at 25 lb. pressure for one hour, reducing the contained moisture to about 30%. The precipitate is cleaned from the presses into rectangular steel cars, 5 ft. 10 in. by 6 ft. 4 in. by 1 ft. deep, in which it is weighed. Based upon the calculated dry weight of the precipitate, flux consisting of 1½% each of borax and bottle glass is added on top without mixing; the charge is then shoveled from the car into No. 400 crucibles. To permit the introduction of a high column of precipitate, a discarded pot with the bottom out is temporarily fitted into the crucible, being removed after the charge has melted down. This procedure reduces dust losses and accelerates charging and melting.

The eight furnaces are oil-fired, built flush with the floor of the melting room on the arc of a circle, with fire pit at rear. This arrangement has proved satisfactory and is to be recommended as convenient and saving labor.

The crucible, upon being lifted from the furnace by tongs attached to ½-in. wire cable, raised or lowered by air cylinder on the post of the jib crane, is swung around to one side to the pouring carriage containing the bullion molds. The slag is first skimmed off, using sand to assist. As the bars are poured, sticks of wood are laid on top and, igniting, prevent too rapid cooling of the center of the bar with the consequent subsidence and holing.

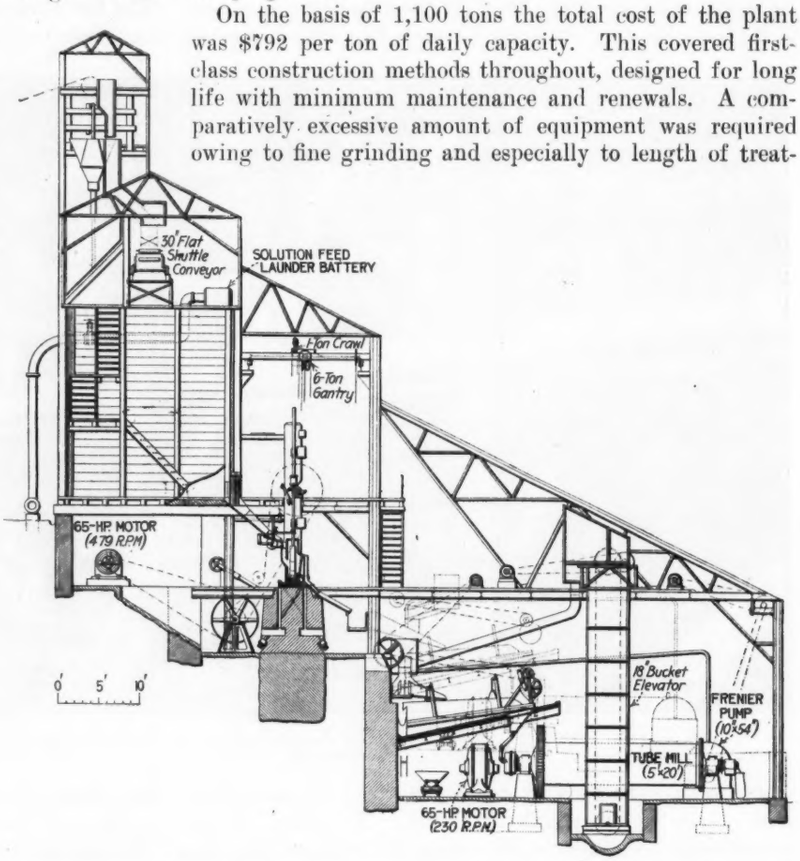
The precipitate averages 85% fine bullion. The doré bars weigh 1,000 oz. and assay 5 gold and 940 silver fine. The No. 400 crucibles contain an average of 7 bars per melt with a maximum of 10 bars. The average life of a crucible is 10 melts, or 70 bars.

With bullion of this fineness no difficulty with matte formation is experienced. The bars are carefully cleaned and all chips and corners removed before sampling and weighing. Drill samples are taken—one on the top of the bar, one-third distance along the diagonal toward the center, and one on the bottom of the bar at one corner. Each hole is drilled halfway through the bar.

The bullion was formerly refined by a French concern in Mexico City, the fine gold being sold to the Mexican government and the fine silver shipped for sale in New York or London. The refinery has been closed down since the outbreak of the war in Europe, so that the doré bars are now refined and sold in New York or London.

As previously described, the tailings sluiced from the Merrill filter presses pass through four Dorr thickening tanks for recovery of water and are then automatically sampled before flowing to the storage basins. These basins, or ponds, four in number, are on the nearest flat land 2 mi. away. The ditch thereto was dug U-shaped, 2½ ft. deep with a 3% grade; 1½% would suffice. The walls of the storage basins are built up as required of tailings, one basin receiving the entire inflow while the others are being prepared. Evaporation and absorption of the solution are high, the decanted effluent representing only 30% of the solution inflow. This solution contains an average of a trace of gold and 0.12 oz. silver, representing filter losses and further dissolving values. A small precipitation plant is being arranged to recover this escaping fraction.

On the basis of 1,100 tons the total cost of the plant was $792 per ton of daily capacity. This covered first-class construction methods throughout, designed for long life with minimum maintenance and renewals. A comparatively excessive amount of equipment was required owing to fine grinding and especially to length of treatment necessary for a silver ore, resulting in unusually large tankage. On the other hand, the all-sliming design without concentration simplified operations and eliminated the installation of concentration equipment.



STAMP MILL AND REGRINDING SECTION OF SANTA GERTRUDIS MILL

Power Distribution

The Pachuca district is supplied with electric power generated by several hydro-electric plants owned by three power distributing companies, practically under one control. The main plant, owned by the Mexican Light and Power Co. and situated at Necaxa, Puebla, about 75 mi. by transmission line to the east, also furnishes energy for Mexico City and El Oro. The 50-cycle alternating current is transmitted at 85,000 volts to the Pachuca substation, where it is stepped down to 20,000 and 6,000 volts for local distribution. The power is sold at the substation

of the purchaser on the basis of integrating wattmeter readings, no peak or installation loads being considered. A power factor of at least 80 to 85% is required of the purchaser, and prices vary from $42.50 to $50 per hp.-year, depending on the amount consumed.

Although most of the mines are wet, there are no reserve steam plants in the district with the exception of a relatively few old steam hoists that could be used for baling in an emergency. Nevertheless the several widely separated bydro-electric plants with individual transmission lines provide a very reliable power supply.

The Benevolent Jin

By Mark R. Lamb*

Once upon a time there was a benevolent Jin whose regular beat was from New York to San Francisco, via New Orleans. This trip, which he described to me, he decided to make along the route of the Union Pacific owing to the congestion of military transportation toward Mexico. Now this Jin was eight cubits tall, so that he was right on top of Utah before he noticed it. One reason for this, besides the smelter smoke, was that the people were buried and hidden in a fog of detail. This fog is not confined to Salt Lake. I do not want to give that impression. In other parts of the world this fog is quite as thick as in Utah. As everyone knows, it is 4 ft. 6 in. deep.

The fog made it difficult for the Jin to detect that the city was the abode of ambitious people. It was so dense that some of the women and all the men moved about with heads very low in order not to miss any details. This meant that a man's back was about all that our benevolent Jin could see of him. As backs are developed with use, they covered the landscape disproportionately, and to such an extent that at first, not being a copper miner and being more acquainted with livestock, our Jin mistook the place for a burro farm.

As soon as he discovered his mistake, he was filled with pity. He tried to attract the attention of those whom it seemed likely could straighten their backs. He pointed out the beauties of life—especially in New York—shouted, in fact did everything that his limited intelligence could suggest to get their heads above the fog, but to no avail. He then set about to find a way to distinguish between those who had aspirations and those who were hopeless detailers.

Now you should know that our Jin was among the most powerful in his own line of work, which had been among simple folk, usually consisting of improving crops, fattening burros, eradicating cattle pests and providing hospitals. But as this Utah job was more a mental than a physical task, he decided to get expert advice.

It would naturally be supposed that the men best posted on the conditions and remedies for Utah would be J—— of New York, the high seas, and elsewhere, and as even a Jin would know that, our hero repaired thither hastily. When he had stated his problem, J—— smiled at him sorrowfully.

"My dear colleague," he said, "you are new at this business. Better stick to your own line. I have been trying to help those people for years, and am discouraged." He sighed hopelessly, and after buying a few mines, went on:

"I have hung up beautiful tempting jewels—and jobs—well within the reach of all my people, and have even provided stepladders for getting to them, but those backs you saw have grown stiff, bending over details."

After pensively signing a few checks for two million or more dollars, he continued:

"I confess that I am at sea on this job. Perhaps the prizes have been too large or have been held so that they looked as out-of-reach as the stars. Perhaps those detailers thought others better fitted to win the prizes, or they may be just plain lazy. Quite likely it is a mixture of all these."

He stopped, bought a smeltery, and after a moment, went on:

"If you knew how I would enjoy and appreciate your success in this venture, you would be still more anxious to succeed. All my work would be play if the men at these plants would straighten their backs from time to time, and get their heads out of the fog of details."

J—— stopped and was silent for a long time, staring disconcertingly at the Jin, who waited in respectful silence. The gentle reader of course knows who J—— is and he is known to all Jinn since the time of his birth. He is held up to all of them as the most powerful human Jin. Our benevolent Jin considered this the opportunity of a lifetime and so waited breathlessly for what would follow. After attending to the necessary detailed arrangements for maintaining the earth in ballance while steam-shoveling a Western mine, J—— sighed again and went on:

The Greatest Problem

"This is just my one serious problem and I am afraid that it will never be solved. The master Jin himself is powerless where he has not the spark of desire to work upon, and I know my limitations."

He paused long enough to put his feet on his desk—because he believes that all supermen should devote a part of the day to thought—and then continued:

"Others, like the editor of the *Journal,* are constantly holding out tempting prizes well within the reach of any of those men and are ever ready to smooth the path to fame with their powerful publisobiles, but few men can see the prizes and the path, while buried in the fog."

He pressed a button which started a 10,000-ton unit, bought a province in Russia—and then hesitated as to where the cables should be sent for the right men. No other task causes him to hesitate.

"I have decided," he said, finally, "that it will do no harm for you to make a trial."

With him, to decide is to act. The bewildered Jin went hurtling through space toward Utah, faster than ever Jin traveled before. He had not realized how every force of nature had been harnessed to copper.

After arriving, he tried to talk to the busiest, hoping to get a hint that would dispel his perplexity. But everyone was busy on details. True, it was no unusual thing to see women standing upright, seeing things clearly above the fog, yet unable to persuade their men to glance up. Upon such and occasion a husband might say to his wife; "Here, take this five hundred and run down to Salt Lake and don't come back until it is all gone. I cannot go with you. It is vitally important to the company that I stay here and complete this detail, as no one else can do it but me."

*Allis-Chalmers Co., Santiago, Chile.

And down would go his head into the fog again, and his back would look like all other backs to J—— in New York.

The wife would look at the five hundred and at the back and then sigh and perhaps go off to Salt Lake and spend a hundred or two and keep the other three against the rainy day when the head comes out of the fog for the last time.

The Jin could easily talk to the women. One suggested a cut in wages as a sort of eye-opener and back-straightener. What seemed the most practical woman suggested a little real shining gold—say two twenties, tied together so as to chink invitingly and supported by a very light string, tied to a pencil but easily broken. This gold was to be held within easy reach of absolutely every man there. She said it might take a day or two to catch their attention, but that surely within a week every man would make at least one quick grab. Wouldn't it seem likely to you that by almost forcing it into their hands, the detailers could acquire at least a longing sufficient to make them look up and about for more of this easy pencil money?

At least the lady convinced the Jin, and he rushed away to New York to lay the scheme before J—— and get his approval.

The latter laughed and approved, but had no hopes of results.

"You may try it for two months," he said. "As for the money, offer real money—not Jin money." He paused.

Gold Bait on a String

"I cannot buy the gold for you, as such a purchase could not be slipped past McG——. You see it would be an unauthorized expense, as no good will result. But I will supply the string."

He opened a drawer and withdrew the end of a stout cord.

"This is unbreakable," he said. "Tie your gold with this. In this way I shall know if you get results. Besides that, the man who grasps the gold will have a string on his desk," and he chuckled at the absurdity of hoping for results. He closed the drawer, leaving just enough room for the string to pay out.

The Jin waited for instructions as to where to get the real gold, hoping that the task would not be too heavy for him.

"As for the gold," J—— went on, "it is a good practice to use that of others, so far as possible." He jingled some gold eagles in his own pocket, but instead of offering these, he said:

"See the editor of the *Journal*. Get him interested and he will supply the necessary gold in the hope that the detailer will use the pencil for him in exchange for the coins."

As the editor had been trying for the same results for years, there was no difficulty in talking him into the scheme, but he was no more hopeful than J—— and knew that his money would remain largely untouched.

If every effort made by the Jin were described, this story would be too long. He worked like the slave he is, urged wives to urge husbands to look up, and held the glittering, tinkling gold before the eyes of each man. He even told who supplied the string—but the fog was too dense.

Now this pencil gold is quite different from detail money. The latter comes as a matter of course—and goes that way also. It has strings on it, but they lead nowhere except to the grocer and his tribe.

Pencil money is velvet, is always unexpected and causes the pleasantest sensation imaginable. Merely to think of it is a delight and actually to receive it is incredible.

But the Jin tore his hair in despair as the days passed and no one touched the pencil gold as it swung back and forth in the sun just above the fog, glistening like a lighthouse and chiming like a dividend. He dangled the money right into the hands of the detailers, but they dropped it, preferring other things. One pushed the coins away to take up a test tube. Another preferred a monkey wrench, though others could better use it.

Our Jin resorted to all sorts of tricks. Unexpected bills would be put over onto a likely looking detailer whose back reached nearly to the top of the fog. Or a wife would be persuaded to pretend illness. These tricks would usually bring a head nearly out of a fog, and sometimes the detailer would begin to reach for the pencil gold, but always a nut or a bolt or a drawing would catch his eye, and down the head would go again, never rising far enough to see the cord reaching to New York.

The benevolent Jin gave up the effort. He returned the pencil gold to the editor and cabled briefly to J——, who, reading, seemed to grow older.

"Lad," he said to the office boy, "wind up the cord."

The cable said:

"J——, New York. You knew best. They are hopeless. Have released string. B. Jin."

Gentle reader, for "Utah" read your own job. For "detail money" see your own miserably small pay check. Publishing something you know is not vanity. Reserving it is. Some engineers are so successful that they do not now need to seek publicity (proper professional publicity). It seeks them. But you are not in that class. You know who J—— is in your case. But does he know you, or does he only see your back?

Computing Income Taxes

By A. L. H. Street*

In computing income taxes collectible from a lessee of mining property who is developing the property on a royalty basis, although he is entitled to a deduction in the assessment to cover royalties paid the lessor, he is not entitled to a deduction on account of ore depreciation resulting from removal of ore mined. So held the Wisconsin Supreme Court lately in the case of Klar Piquett Mining Co. vs. Town of Platteville, 157 Northwestern Reporter, 763. It was unsuccessfully claimed by a lessee in this case that the last-mentioned deduction was proper on the theory of the lessee's ownership of underlying ore.

The reason for the decision appears in the following extract thereof: "The price paid by the lessee of a mine for ore taken out measures the cost of the raw material to him in the form in which he takes it. To this, of course, must be added the cost of mining and marketing, including depreciation to plant and other proper expense connected with the business, to arrive at the actual cost thereof."

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The Chemistry of Minerals

By Joseph E. Pogue*

SYNOPSIS—The chemical composition of a mineral is rarely limited to those elements that give it its characteristics and as which it is usually known. The discussion here bears upon the impurities usually present and their effect upon some minerals.

The idea that all minerals are natural substances with definite chemical and physical properties must be modified, for it is now well known that the chemical composition and physical properties of many minerals—of most minerals indeed—vary within certain limits. These variations for the most part are not to be attributed to chance impurities having fortuitous connection only with the mineral, but rather are inherent in the chemical make-up of the mineral itself and are therefore to be looked upon as characteristic, just as definite properties are regarded as critical and diagnostic.

Chemical composition has long been recognized as a fundamental feature of minerals, conditioning the other properties. Customarily it is expressed by means of exact chemical formulas: $CaCO_3$ for calcite, $KAlSi_3O_8$ (better written $K_2O\ Al_2O_3\ 6SiO_2$) for orthoclase, and so on. A formula is derived from a quantitative analysis and represents the proportions in which the component elements combine. Rarely does an analysis of a mineral yield results that agree absolutely with the theoretical or ideal composition indicated by its formula. In the case of minerals of simple composition, such as quartz, gypsum and fluorite, the difference is slight and lies within the errors of analysis. With minerals of more complicated composition, however, and indeed with many of simple composition, the variation is greater than can be attributed to the analyst, whose errors may now be held within reasonable bounds, and expresses a characteristic of the mineral itself. To focus upon the constancy of minerals and overlook their variability is to miss half their meaning.

In light of our present knowledge, chemical variability among minerals may be attributed to several factors among what are intercrystallized impurities, adsorption of foreign material by colloidal minerals (a form of solid solution), solid solution of isomorphous crystalline substances, solid solution of nonisomorphous crystalline substances and chemical alteration.

Foreign Material Present in Crystals

Minerals form in several ways—they are deposited from solutions either hot or cold; they separate from molten rock material (magma); they are deposited by vapors and gases, etc. The conditions attending their formations are complex, many chemical elements are present, and ideal purity is seldom attained.

If the mineral has time and opportunity to crystallize, it attempts to attract to itself only its own elements and to repel all foreign substances approaching its neighborhood. Some alien material, however, almost invariably becomes entangled and tends to crystallize as minute crystals, contaminating the purity of their host. Few transparent minerals, if thinly sliced and viewed under the high power of a petrographic microscope, fail to show a varying number of such foreign bodies. Even quartz, which ranks among the purest of minerals, often contains tiny bubbles of liquid carbon dioxide or other impurities and thus falls short of absolute integrity. And since the metallographic microscope has been directed to polished surfaces of opaque ore minerals, many of these have displayed an intimate intercrystallization of associated minerals, in some instances visible only under the highest attainable magnifications. The minute graphic intergrowths of bornite and chalcocite noted in ores from Virgilina in Virginia, Mount Lyell in Tasmania, and Butte in Montana attest the tendency of sulphide minerals to intercrystallize.

There is every reason to believe that crystallized impurities range down to submicroscopic size; the limit of microscopic visibility is set by the wave length of light, a breadth requiring thousands of molecules to span and giving ample space for crystallization.[1] Many observations bear out this belief. The titaniferous magnetites, for example, as shown by detailed microscopic studies, made by J. T. Singewald, Jr., for the Bureau of Mines, consist of intergrowths of magnetite and ilmenite, the latter in many cases present as minute lamellæ ranging down to 0.001 mm. and smaller in width; yet some specimens in which no ilmenite was microscopically visible analyzed as high as 6% Ti, a result strongly suggesting the presence of nonmicroscopically visible ilmenite.[2]

Cupriferous pyrite forms a second example; for while the copper value has been shown repeatedly to be due to intergrown chalcopyrite, in some ores, notably those from Mount Lyell in Tasmania, copper was detected in fragments free from microscopically visible chalcopyrite, yet adjoining pieces of ore invariably disclosed chalcopyrite in minute microscopic development. Of course we must draw the line somewhere between physical intergrowth (intercrystallization) and molecular intergrowth (solid solution), but the limit of microscopic visibility is too obviously artificial to select.

When minerals fail to crystallize or crystallize only imperfectly, they possess less power to eject impurities, and such minerals are apt to be more impure than well-crystallized ones.

Adsorption in Mineral Composition

This brings us to a class of minerals in which a process called adsorption plays an important part in conditioning chemical composition. This process is of chief importance among amorphous minerals—those characterized by lack of orderly molecular arrangement. It seems that minerals solidifying with molecular orientation—that is to say, crystallizing—tend to expel foreign material, while minerals solidifying with haphazard molecular assemblage not only lack this self-purifying power, but even in many

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[1] The limit of microscopic visibility varies from 0.0008 to 0.0004 mm.

[2] Singewald, however, concluded that this result appeared to indicate that the magnetite molecule itself carries titanium in isomorphous relation with the iron, forming so-called "titanomagnetite."

cases attract or adsorb impurities. Hence the importance of knowing whether we are dealing with a crystalline mineral or with an amorphous, or as we now say, colloidal one.[3]

All minerals that show an amorphous (noncrystalline) character under the microscope—and this condition is usually expressed outwardly in a wax- or gum-like appearance and rounded surfaces—are to be regarded as solid colloids, or gels.[4]

Now, crystalline minerals have separated from ordinary solutions or from igneous melts or vapors. Gels, or colloidal minerals, on the other hand, have formed from colloidal solutions. It is important, then, to understand clearly what a colloidal solution is and how it differs from a true solution.

A true solution is a suspension in some liquid of simple molecules or of molecules wholly or in part broken up into electrically charged particles known as ions. These molecules and ions show no tendency to settle, but on the contrary they spread out or diffuse until they are evenly distributed through the solvent. They cannot be separated mechanically; they are small enough to pass through the pores of filters, membranes and rocks.

Colloidal Solutions and Their Variations

A colloidal solution is one in which the dissolved substance is finely divided, the particles being larger than the calculated size of molecules, yet smaller than discrete particles visible under the microscope. These particles are not in mere mechanical suspension—they are under other influence than gravity and viscosity. They are electrically charged (most are negative) and in constant motion. Unlike the particles of true solutions, they do not diffuse or diffuse but sluggishly, and they have little effect upon the boiling and freezing points of the solution. They are held in suspension by their surface tensions and electric charges; often, too, by the presence of substances like hydrogen sulphide or certain potassium salts, known as dispersing agents. Upon the escape of these agents or upon the addition of other substances that dissociate into ions bearing charges opposite to those of the colloidal particles (substances known as coagulating agents), or merely upon the evaporation of the liquid, the suspended matter separates. This precipitate may crystallize forthwith or settle slowly as a jelly, occluding some of the solvent and slowly hardening into a solid colloid, or gel. The jelly, while hardening, and even after solidification, acts adsorptively upon material left in solution and supplied by later solutions, drawing in and permanently holding more or less of such. The process seems to be conditioned, in part at least, by the enormous surface exposed by colloidal aggregates and the excessive surface tension set up thereby and is not in the main due to chemical affinity in the ordinary sense.

Now, minerals that have formed from colloidal solutions show strong variations in composition, due to this process of adsorption. Many are adsorption compounds, differing from chemical compounds in the essential fact that the components are not present in definite, but in variable, proportions. Chrysocolla, hydrous copper silicate, is an example of such a compound. It is a typical colloidal mineral, amorphous, variable in composition. It is to be regarded, not as a definite chemical compound, but as a homogeneous mixture of CuO, SiO_2 and H_2O in varying proportions—a solid solution of these components. Here the three components are essential.

There are other colloidal minerals showing varying qualities of adsorbed impurities, but such occluded or dissolved material should be discriminated with care from other components which, though present in minor amount, give important characteristics to the mineral. Psilomelane forms a good example of a mineral in which it is difficult to distinguish between adsorbed components and adsorbed impurities. Chemically, it is chiefly MnO_2 with minor but variable MnO, BaO, K_2O, Cu_2O, H_2O, etc. Its nucleus is MnO_2, and the other compounds were adsorbed during formation or, in part, later. Remove them and the mineral breaks down; it derives certain of its essential qualities from them—its hardness, for example, from the BaO. Obviously, then, certain of these components must be regarded as essential components, even though they do not fit into any definite chemical formula. Indeed, they are not present in chemical combination at all.

There is a certain type of colloidal solution, exemplified in nature by silicic acid and characterized by high viscosity, in which the suspended particles are not rigid but plastic; these solutions represent colloidal emulsions. Like colloidal suspensions[5] they harden, or set, to gels. Their presence even in small quantity in a colloidal suspension greatly increases the stability of the suspension; hence they have been called protective colloids. They undoubtedly have a very important, and as yet little understood, bearing upon mineral formation.

Experimental work on silicic acid and hydrates of iron, aluminum, chromium, etc., has shown that these compounds, hardened from a colloidal emulsion, are not definite hydrates, but show a water content in delicate adjustment with that of the surrounding atmosphere. May we not expect that the water of gelatinization bound up in natural hydrates (limonite, bauxite, etc.) may ultimately tell us many details of the climatic conditions under which such minerals developed? Indeed we already realize that colloidal minerals are mostly formed at or near the surface by the processes of weathering, while crystalline minerals are in general a product of greater depths and higher temperatures. Since weathering is largely dependent upon climatic conditions, we have in colloidal minerals a key to the climates of the past. Felix Cornu pointed out in 1911 that the earth could eventually be divided into typical gel regions of significance in conditioning plant and animal distribution.

Characteristics of Colloidal Conditions

As to the molecular condition of material adsorbed by colloidal minerals we cannot speak as yet without reservation, but from the fact that colloidal jellies present a difficult barrier to colloidal solutions, although they readily permit the diffusion of salts (electrolytes), we may presume that substances absorbed—at least those absorbed—at least those absorbed after the solidification of the mineral—are not necessarily colloidal themselves, but may be crystalline or in an ionized condition. Diffusion

[3]The term crystalline refers to inward structure as opposed to crystallized, which signifies outward shape. Every crystallized mineral is crystalline, but the reverse is not true. The word crystalloid is convenient for designating a mineral that is not amorphous—that is, not a colloid.

[4]A coagulated colloidal solution is called a gel because of its jelly-like nature. The term is also applied to a mineral so originating.

[5]Colloidal solutions in which the suspended particles are rigid—the common type of colloidal solution in nature.

processes (of which adsorption in colloids is one effect) are of far-reaching importance in nature, and have been recently emphasized in the researches of Liebgesang, who has discovered and investigated in particular a process of rhythmic precipitation especially potent in colloidal media and bearing, therefore, on mineral formation. The results of this process are best illustrated by the agate, which is no longer to be regarded as deposited in concentric bands, but as developed by the slow diffusion of iron salts through a silica jelly with precipitation of an iron compound at regular intervals through the mass. Periodic or rhythmic precipitation in colloidal substances may be produced in the chemical laboratory, and the principle has been advanced to explain such geological phenomena as weathering rings and certain types of banded ore structures.

The adsorptive power of noncrystalline compounds is well shown during the course of a quantitative analysis by ferric hydroxide, which is precipitated in colloidal condition and brings down with it phosphoric acid, boric acid, etc. Among mineral substances no better example could be adduced than fuller's earth (a colloidal clay), which possesses to a notable degree the power of removing color from fats, oils and greases. The ability of kaolin to adhere to the tongue illustrates its strong adsorptive power.

Ability To Scatter and Polarize Light

Substances in colloidal suspension have the ability to scatter and polarize a beam of light. Glass can be given a ruby color by diffusing colloidal gold into it. Many minerals owe their color to traces of material present in colloidal suspension, and this conception is clearing away much of our uncertainty in the long obscure field of mineral coloration, even serving to explain some of the color changes developed upon exposure to radium emanations. Halite, for instance, has been shown to owe its shade in many colored varieties to diffused colloidal sodium. Such halite loses its color upon heating, regaining it when heated in vapors of metallic sodium or exposed to radium rays.

Many minerals resemble colloids, but have internal fibrous or foliated structures. Such may be called metacolloids, as suggested by Wherry. Examples are chalcedony, limonite, malachite, serpentine, etc. These were originally colloidal, but have become more or less crystalline through simple molecular arrangement.[6] Adsorption occurs in metacolloids, so the crystallinity of such compounds does not guarantee their purity.

In some minerals we may have a mixture of crystalline and colloidal components. For example, meerschaum (sepiolite) from the Grecian Peninsula has been shown to consist of a mixture of a fibrous silicate of constant properties with a gel. This gel portion was found to stain intensely, a result of its adsorptive power, while the crystalline portion was unaffected in the presence of the stain. It is supposed that the mineral was originally deposited as a colloid and that the crystalloid formed slowly from the colloid, the change not having proceeded to completeness. Bauxite from Arkansas has lately been described by W. J. Mead as composed principally of a mixture, in variable proportions, of crystalline and amorphous $Al_2O_3\,3H_2O$, a substance existing independently as the mineral gibbsite. The tendency in the past with this information would be to demote bauxite from the rank of a mineral. Yet we now look upon bauxite as a distinct species, though both chemically and physically unhomogeneous.

[6]It should be remembered that any substance, amorphous or crystalline, may take on the colloidal condition, and conversely that colloidal solutions may give rise to either crystalloids or gels, although the latter are the usual products.

Phases of Solid Solutions

We come now to crystalline minerals that show variations in composition not due to impurities mechanically enclosed nor, as in colloidal minerals, to substances adsorbed, but arising from the fact that such minerals represent varying mixtures of two or more orderly sets of molecules. There are two types of such homogeneous molecular mixtures, or solid solutions[7] as they have been termed: The first where the substances are similar in character and mutually replaceable without greatly modifying the character of the resulting mineral; the second where the substances are dissimilar and not mutually replaceable, the resulting mineral differing greatly according to the relative proportions of the components. The first, which may be called the isomorphous-mixture type of solid solution, has long been known and studied, whereas the importance of the second, which may be termed the mix-crystal type of solid solution, has not been adequately recognized.

Many compounds of allied chemical composition show nearly identical crystal forms and closely related properties. Such compounds are isomorphous—that is, of the same form. For example:

Calcite	$CaCO_3$	—Rhombohedral crystallization
Magnesite	$MgCO_3$	—Rhombohedral crystallization
Siderite	$FeCO_3$	—Rhombohedral crystallization

Isomorphous compounds are capable of mixing in varying proportions to form solids that appear perfectly homogeneous under the highest magnifications of the microscope. The resulting substance may be looked upon as a mutual interpenetration of two like molecular structures, a complete merging of components to form a new product. Isomorphous compounds are miscible in the solid state just as alcohol and water in the liquid condition.

Many minerals are isomorphous mixtures of two or more components. Thus the mineral ankerite is an isomorphous mixture of calcium carbonate, magnesium carbonate and iron carbonate; $x\mathrm{CaCO_3} + y\mathrm{MgCO_3} + z\mathrm{FeCO_3}$, or, as the formula is usually written, $(\mathrm{Ca,Mg,Fe})\mathrm{CO_3}$. This means that the proportions of the carbonates of calcium, magnesium, and iron are variable; or expressing the same thing in another way, that we have calcite ($CaCO_3$) with part of its calcium replaced by an equivalent quantity of magnesium and iron.[8] Only elements capable of forming with the CO_3 radical a compound of the same form as calcite would be able to enter into such relationship. In some ankerites a small percentage of manganese is present. Now, manganese forms a carbonate ($MnCO_3$, the mineral rhodochrosite), which is rhombohedral, hence we regard the manganese carbonate as present in isomorphous relationship.

The isomorphous components of minerals are called isomorphs. In some minerals two or more isomorphs mix in all proportions, giving rise to isomorphous series (as in

[7]The term "solid solution" was applied to crystalloids long before it was seen to be applicable to colloidal minerals.

[8]Isomorphous replacement, a term often used, refers to the introduction of an isomorphous compound into a substance, and a mineral showing isomorphous replacement is merely an isomorphous mixture.

the case of plagioclase feldspars); in other minerals one isomorph dominates the others (one or more). The second condition is the more common, and a great many minerals owe their chemical variability to the presence of isomorphs in small amounts. For instance, sphalerite (ZnS) generally carries more or less iron—present in the form of an isomorph (FeS) so that the formula of sphalerite is correctly written $xZnS + yFeS$, in which x always exceeds y.

The plagioclase feldspars form a striking example of a mineral series that represents all mixtures of two isomorphs. We may express their composition thus:

THE PLAGIOCLASE FELDSPAR SERIES

$Na_2O\ Al_2O_3\ 6SiO_2$ = Ab (albite molecule)

Albite	$Ab_1\ An_0 — Ab_6An_1$
Oligoclase	$Ab_6\ An_1 — Ab_3An_1$
Andesine	$Ab_3\ An_1 — Ab_1An_1$
Labradorite	$Ab_1\ An_1 — Ab_1An_3$
Bytownite	$Ab_1\ An_3 — Ab_1An_6$
Anorthite	$Ab_1\ An_6 — Ab_0An_1$

$CaO\ Al_2O_3\ 2SiO_2$ = An (anorthite molecule)

While all the members of this series crystallize in the triclinic system, certain of their properties, such as indices of refraction, vary progressively as more of the anorthite molecule enters in. Indeed, the chemical composition of a plagioclase feldspar may be very accurately and conveniently determined by measurement of its physical properties. A further complication in composition is caused by the fact that a single crystal of a plagioclase feldspar may be zonally developed, the zones differing in composition. This structure is not uncommon, and the innermost zone is apt to be the most calcic, the successive zones outward ranging more and more sodic. But here we have in reality an intergrowth between two or more minerals, even though such minerals be closely allied members of an isomorphous series. This same sort of thing is seen within many isomorphous series.

Isomorphs By Tungstates of Iron and Manganese

Another notable example of isomorphs admixed in all proportions is formed by the tungstates of iron and manganese, well described by W. T. Schaller in Bulletin 583 of the United States Geological Survey. A total of 95 analyses have been made of members of this series, which are found to range all the way from nearly pure $FeWO_4$ through intermediate mixtures of $FeWO_4$ and $MnWO_4$ to almost pure $MnWO_4$. It becomes necessary then either to consider the whole range as embracing a single mineral or to make arbitrary divisions and assign a mineral name to each. As the mineral names ferberite, wolframite and hübnerite were already in use for natural compounds falling within this series, Schaller proposed that these names be maintained but confined to particular combinations, as

$FeWO_4$ = Ferberite (pure to 20% hübnerite molecule)
$(Fe,Mn)WO_4$ = Wolframite (ferberite molecule 80%—20%)
$(Fe,Mn)WO_4$ = Wolframite (hübnerite molecule 20%—80%)
$MnWO_4$ = Hübnerite (20% ferberite molecule to pure)

The point has been raised by E. T. Wherry that such "arbitrarily partitioned-off portions of isomorphous series are not to be regarded as definite minerals," and he proposes that in all such cases it is better to use chemical prefixes to indicate where in the series a mineral substance lies; thus, for example, calling ferberite a ferro-wolframite, hübnerite a mangano-wolframite and so on. But this is merely a question of nomenclature; the fact remains that here we have a range of compositions, and while a given specimen corresponds to a definite point in this range, no two specimens may be expected to be chemically the same, and the mineralogic unit is not a point nor even any arbitrary section, but the entire range itself.

The physical properties of any mineral affected by isomorphism are modified by the isomorph entering in proportion to its character and amount. And the modification is in general a perfectly regular one, capable of being expressed graphically by curves, so that when the relation between composition and properties is worked out in detail for a given mineral, the physical measurements assume a new meaning, conveying chemical information that could not be obtained otherwise than through a laborious analysis.

Another Variation of Solid Solutions

We have just considered a type of solid solution common among crystalline minerals, in which the component substances are closely related chemically and replace one another in the crystal structure. We now come to a second type of solid solution of equal rank with the first named, its importance as yet scarcely recognized, which has been termed the mix-crystal type. This is a solid solution in which the component substances are widely different in character—so different that they are nonisomorphous and not mutually replaceable in the crystal structure, but upon mixing give a new type of crystal structure, a compromise between the two merging ones. Among minerals this kind of solid solution may show itself through small ranges where one component dominates and the other enters in small proportion only, affecting but slightly the physical character of the mineral; or we may find the two components mixing through a wide range or even in all proportions, giving rise to a series of distinct minerals differing markedly in crystallization and other properties.

The composition of a number of minerals has been cleared up by an application of these ideas of solid solution to their study. The mineral nephelite forms a good example. Its composition approximates $NaAlSiO_4$, but many specimens hold 2% too much silica to be consistent with this formula. This fact has long been puzzling, and the formula of nephelite has consequently been in dispute, but recent investigation goes to show that this excess of silica exists in the mineral dissolved in the $NaAlSiO_4$. The molecular condition of this "dissolved" silica is not definitely known, but it has been suggested that it is present in the form of $NaAlSi_3O_8$, a compound existing independently as the mineral albite. If the excess silica is present in this molecular condition, then we have tricline albite dissolved in hexagonal nephelite up to 2% in quantity, that figure apparently representing the "saturation limit" of nephelite to albite.[9]

Pyrrhotite forms a second example, with its sulphur content varying from 36.3% to over 40% without causing marked change in properties. If the excess of sulphur be regarded as present in solid solution, dissolved in the normal pyrrhotite, then the variation in composition found in this mineral becomes readily understandable. Thus pyrrhotite is theoretically FeS (a compound found only in meteorites) but practically FeS + variable S, the sulphur above that required for the FeS molecules ranging up to 6%. The dissolved character of this extra

[9] It need scarcely be pointed out that such a question cannot be settled by the microscope, for the dissolved material is present in submicroscopic condition and does not affect the homogeneous appearance of the mineral.

sulphur has been proved in the Carnegie Geophysical Laboratory at Washington by actually dissolving sulphur in synthetic FeS up to a maximum of 6.04% at 600°.

E. H. Kraus and J. P. Goldsberry have recently completed a very suggestive study of bornite, a mineral whose formula has long been in doubt, owing to a striking divergence in the results of analyses of specimens from different localities. These investigators show that bornite is not a definite compound in the ordinary sense, but is made up of a mixture of Fe_2S_3 (a compound not found uncombined in nature) and Cu_2S in proportions ranging from $3Cu_2S\ Fe_2S_3$ to $38Cu_2S\ Fe_2S_3$, the majority of analyses corresponding to $5Cu_2S\ Fe_2S_3 (Cu_5FeS_4)$, which represents the dominant type of bornite found in nature.[10] These mixtures are not confined to the range occupied by bornite, but in other combinations give rise to the common chalcopyrite and chalcocite and the rare copper-iron sulphide, barnhardtite, as indicated in the accompanying tabulations:

THE COPPER-SULPHIDE COMBINATIONS

	Fe_2S_3
Chalcopyrite	$Cu_2S\ Fe_2S_3$
Barnhardtite	$2Cu_2S\ Fe_2S_3$
Bornite	$3Cu_2S\ Fe_2S_3$
	$4Cu_2S\ Fe_2S_3$
	$5Cu_2S\ Fe_2S_3$ etc.
Chalcocite	Cu_2S

Other series of sulphide minerals, such as the As_2S-PbS series, the Sb_2S_3-PbS series, etc., are shown to be analogous in make-up to the Fe_2S_3-Cu_2S series, and a great number of other minerals may be regarded as derived from members of these series by isomorphous replacement in one or both component parts.

Three Types of Solid Solution

Solid solution is not confined to crystalline minerals, but shows itself, as we have seen, in colloidal ones also—for example, in chrysocolla. Thus we may have three types of solid solution, according to whether the components are (1) isomorphous crystalloids, (2) nonisomorphous crystalloids or (3) colloids. Variations in composition may arise further through isomorphous replacement in one or both members of a nonisomorphous mixture or through a mutual solution of a crystalloid and a colloid.

We come now to a consideration of those changes that may take place within the mineral itself to alter its make-up. We know that conditions within the earth's crust are constantly changing and that minerals are often subjected to surroundings unfriendly to their existence. As in organic nature, so among minerals, there is a struggle for existence. Minerals are stable only in the habitat of their birth; with changing conditions somes chemical attack. Hence the tendency of minerals to alter. So today a chemical examination always precedes the quantitative analysis, not only for the purpose of detecting crystallized impurities, but also to determine if chemical alteration has taken place. And while well-developed crystals are usually most free from chemical degradations, even these may show incipient alteration, so insidious and penetrating are forces hostile. Examples are too abundant to enumerate, from the olivine with its microscopic network of serpentine to the complete pseudomorph, where we find, for example, that a crystal of pyrite (FeS_2) has changed completely to hydrated iron oxide (limonite).

[10]A. F. Rogers, commenting on the work of Kraus and Goldsberry, has advanced the belief that bornite is a solid solution of Cu_2S in Cu_5FeS_4, the variable composition being due to the variable quantity of Cu_2S held in solution.

Minerals vary greatly in their inherent susceptibility to decay. Some, like quartz, inert chemically, are stable under varied conditions; others. like marcasite, extremely sensitive to surroundings, alter with ease and rapidity, even amid the sequestered surroundings of a mineral cabinet. So prone indeed are some minerals to decay that perfectly fresh specimens have never been obtained, and with such it becomes necessary to interpolate, so to speak, using the knowledge gained from other minerals to arrive at an understanding of these altered examples.

Chromite Production Increasing

The chromic ore mines of the Pacific Coast have been recently examined by J. S. Diller, of the United States Geological Survey, who reports an increase of production since the transcontinental railroads have so reduced freight rates as to enable the chrome ore produced on the Pacific Coast to compete with the ore imported on the Atlantic border.

For many years California has been the only state producing chromite, and it is still the chief producer. Its production is far greater than ever before. Its output during the first six months of 1916 was more than three times the greatest annual yield of former years and is still increasing. The chief producing areas are the belts of serpentine in the Sierra Nevada and Coast Ranges, which are distributed through a score of counties. Shasta County is still the greatest producer and contains the largest ore body yet discovered in the state.

Nearly all chrome ore is taken out of open quarries. Most of the orebodies are small and lenticular in shape, containing from 1 to 200 long tons of ore. Few contain as much as 1,000 long tons of ore. Bodies of chrome ore have recently been discovered in different parts of Oregon, where production has already begun. The development of some promising bodies is awaited with interest.

Conditions at Pachuca, Mexico

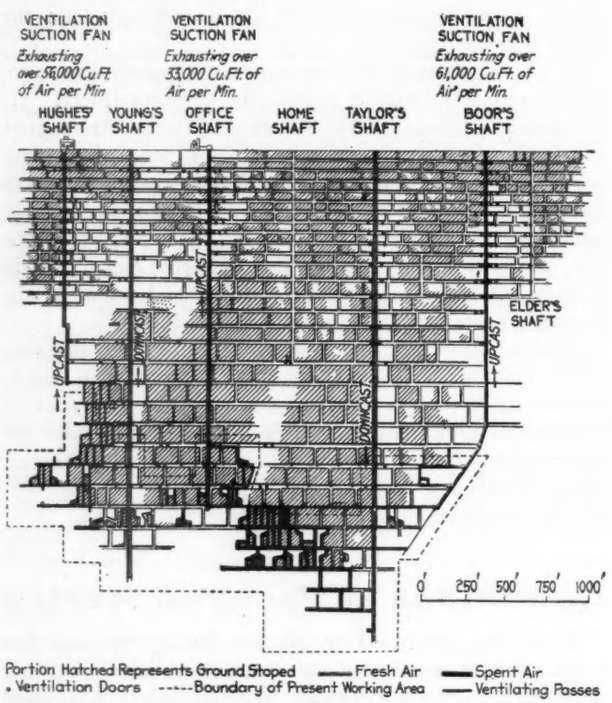
Operating conditions in Mexico during the last few years have been affected by many unusual difficulties, although the Pachuca district, perhaps, has been as good as any for maintaining a fair rate of work. This has been due principally to its advantageous geographical location, numerous railroad connections and steady power service. Added to these favorable factors, there has been coöperation among the mining companies and considerable resourcefulness in looking after the labor and in bringing in supplies.

Like other countries at present under strain, Mexico has found it necessary materially to increase all taxes, including those on mining property and on metals produced and exported. Luckily the prevailing high metal prices still enable the silver and base-metal producers to make a profit, but the gold-mine owner is hard hit with no rise in the market price of his product to offset steadily increasing costs as affected by the taxes, higher prices for supplies, etc. The labor outlook is not encouraging. As a natural outcome of several years of revolutions, labor is also passing through a similar period of unrest and much tact combined with fair and firm treatment will be necessary to meet this situation successfully.

Details of Practical Mining

Ventilation at Wallaroo Mines

The increasing depths at Wallaroo mines and the lengthy levels to be operated emphasized the importance of providing the best ventilation possible, says the annual report for 1915 of the Wallaroo & Moonta Mining and Smelting Co., Adelaide, South Australia. A great deal of work has been done to improve the circulation of the air currents, in connection with which a Sirocco fan has been installed at Office shaft. This additional fan, in conjunction with those controlling the drafts at Boor's and Hughes' shafts, has provided a much more satisfactory



SHAFT AND VENTILATION SYSTEM AT WALLAROO, AUSTRALIA

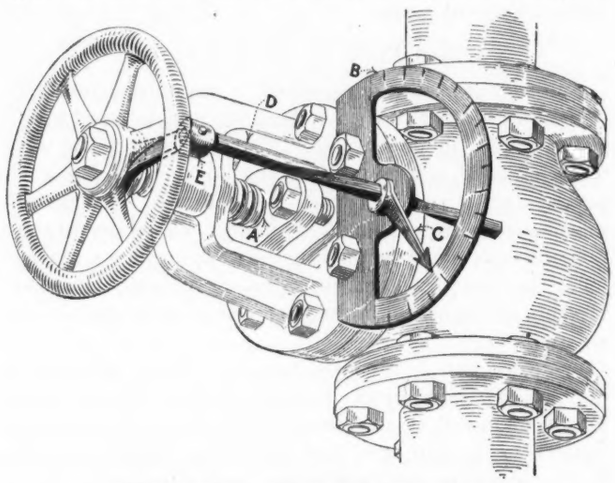
atmosphere than would otherwise have been possible in connection with the rapidly increasing depths to which it has been necessary to extend operations. The shafts mentioned have been deepened so that they may command the air currents at the lower levels. Special attention has also been paid to the maintenance of subsidiary fans, besides over 350 doors in the levels throughout the mine, as well as to a considerable number of "stoppings" at various places. The accompanying illustration shows a section of the ventilating arrangements in the workings at Wallaroo mines and gives some idea of the magnitude of the scheme in operation and the efforts being made to give the best possible conditions in the working faces. The six shafts are shown, their comparative depths and the level communications at various depths. The shafts equipped with ventilating apparatus are noted with the volume of air moved per minute.

An Ingenious Valve Indicator*

By S. F. Jeter

The need for an indicator or telltale to show the exact position of a throttle or other valve, particularly where it is not readily accessible for trial, is often experienced by engineers. The writer recently saw a simple and ingenious device for this purpose, which is applicable to any type where the stem travels with the valve. Such a contrivance is used on the throttle valves of the large reciprocating units at the Pratt Street power house of the United Railways and Electric Co., of Baltimore, Md., and was designed by Malcolm Wright, chief engineer.

The construction and operation are shown in the illustration, where *A* is the valve spindle and *B* a graduated quadrant fastened rigidly to the body of the valve. The pointer *C* is fastened to the quadrant, but is free to revolve over its face. The center of pointer *C* is pierced by a square hole that fits neatly over a square rod *D*. The rod *D*, through a clamp *E*, is made to follow the movement of the valve stem in and out as the valve is operated, and the part of *D* that engages the pointer *C*



INDICATOR ATTACHED TO VALVE

is twisted so that from the open to the closed position of the valve the pointer *C* will travel 180° over the quadrant.

A Drill-Collaring Machine

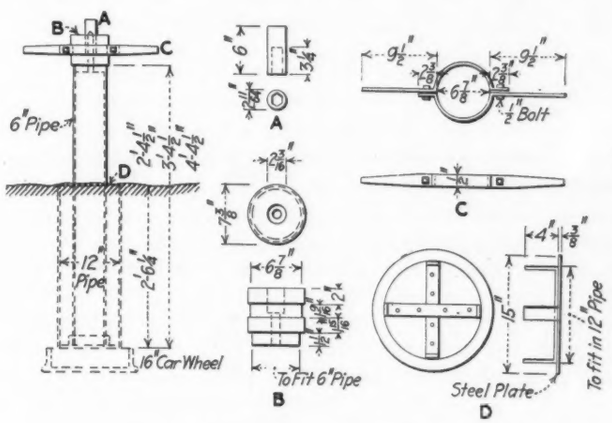
By E. W. R. Butcher†

A contrivance for upsetting collars on mine drills and augers has been devised in the blacksmith shop of the Republic Iron and Steel Co., at Gilbert, Minn., which has given satisfactory service. The parts were made entirely of scrap material, consequently the cost was small. As will be seen in the illustration, a piece of 12-in. pipe is placed under the shop floor in a vertical position, its

*"Power," June 27, 1916.
†Gilbert, Minn.

top flush with the floor. The pipe rests on the top of an old car wheel that has been plugged up with iron and planed on one side, the planed side being placed up. This arrangement permits the handling of long drills. When the device is not in use, the hole is covered with an iron lid, *D*.

Three types of drills are in use—3, 4 and 5 ft. in length—for which there are three lengths of 6-in. pipe, as indicated. Each piece of pipe is fitted with a flange to keep it in a vertical position. In upsetting auger drills a piece of steel 9 in. long is used. The collar is upset in a manner similar to that used for the drills, the die being placed on the steam hammer or other solid surface instead of on the 6-in. pipe. After the collar is made, the piece is welded to the auger proper. The die *B* is made from an old locomotive axle and is fitted with a set of handles *C*. The cup *A* is of tool steel and tempered on top. It can be made with either a circular or a hexagonal hole. When a circular hole is used, it is necessary to reheat the end of the drill and reshape it slightly. In either case the outer end of the hole is



DETAILS OF COLLARING MACHINE

made a little larger than the inner end to allow the drill to slip off more readily.

In upsetting the collar on the drill, the end of the steel is first heated to the proper temperature and then dropped through the hole in the die, heated end up, and the cup placed over the end. The cup is then hammered down quickly, causing the steel to spread out below the end of the cup and forming the collar. The hole in hollow-drill steel is not closed up in this process. The drill is removed with the die by means of the handles, a tap on the end of the drill being sufficient to loosen it.

An Inexpensive Exploration Plant

Often the preliminary examination of a prospect warrants a small amount of development work prior to a more detailed examination. The necessary plant to accomplish this must be cheap, easily available and in good enough condition to last out the short time it is in operation without excessive renewals.

Being called upon for a plant of this character in a region where mining was not a common industry and which was a prohibitive distance from mine-supply houses, it was necessary to procure what equipment was available rather than specially designed apparatus.

A canvass was first made of the two nearest large cities to find the general cost of pumps, piping, hoists, compressors, etc. A visit to a few dealers in this type of machinery soon showed that the cost of new machinery was prohibitive. A tour of the second-hand machinery dealers gave much more favorable results. With a little dickering it was possible to make an arrangement with them whereby machinery could be bought in good second-hand condition—that is, in operating order for a short time—and if brought back in acceptable condition within a year, a refund of 50% allowed.

A horizontal wood-burning boiler of the type used for operating small sawmills, about 15 to 20 hp., cost $150. A hoist of 2 tons capacity, of the type used in connection with hoisting masts in construction work, was available at $125. A small boiler-feed pump, having a capacity of 35 gal. per min., cost $60. A small air compressor cost $150. Three air drills from a quarry cost $60 each. Four contractors' hand-dump cars cost $25 each. A crude skip was made by the second-hand dealer out of an iron barrel and two pairs of car wheels for $50. Pipe fittings, pipe, track, drills and tools cost $185. This entire plant thus cost $1,000, with a possible return of $400 if the large pieces were returned within a year in any usable condition. Of course the pipe, drill steels, etc., were best counted as nonreturnable.

Such a plant was capable of considerable flexibility in use. The pump could be used for sinking or could be given a permanent location at the completion of sinking operations. An arrangement of valves provided for the use of the hoist or compressor at will.

A plant of this character is crude, inefficient and trying on the nerves of the operator, but it can be made to operate and will greatly assist the development of a property at the minimum outlay for the plant.

Sampling Placer-Gravel Deposits

By Irving Herr*

It was desired to determine as closely as possible, before starting to drill a certain gravel deposit, what would be the probability of obtaining reasonably accurate results with a given number of holes and the advantage of increasing the number of holes with variable spacing. The deposit in question had already been partly worked by hydraulic methods and was known to consist of a major portion of low-grade gravel with occasional portions containing fairly rich paystreaks near the bedrock, and also irregular areas of enrichment on the bedrock. These rich portions were irregular both in area and in location.

In order to obtain this information the following experiment was tried: A field 10 in. square was laid out on a piece of tracing cloth to represent a gravel deposit 2,000 ft. square. On this miniature field irregular areas of varying size, shape and location were plotted to represent the rich areas, and the total area of these patches was made for convenience one-tenth of the total area of the field. They were assumed to increase the average value of the gravel overlying them to $0.25 per cu.yd.; and the remaining nine-tenths of the field was assigned an even value throughout of $0.05 per cu.yd. The average for the entire field was $0.07 per cu.yd.

*Mining engineer, Cambridge, Mass.

The various drilling systems were plotted on cross-section paper, each 1 in. square representing an area 400 ft. square, or 1% of the area of the field. The tracing cloth was then superimposed upon the drill-hole plat and the number of drill holes striking the enriched areas was counted. To eliminate the personal equation, the exact position of the gravel field on the drilling plat was fixed by drawing corners slightly outside or inside of the real corner of the field and at small angles to the sides of the field, and the field was then applied so that this arbitrary corner coincided with the corner of the drilling plat.

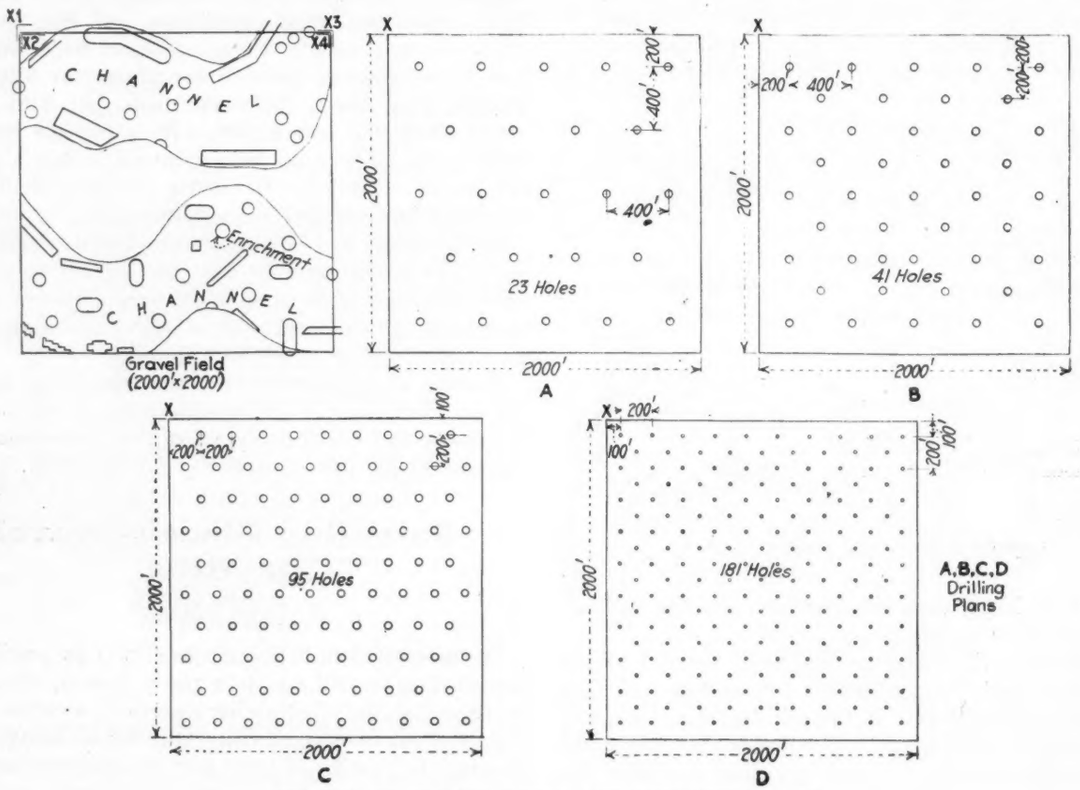
Each system of drilling could be applied to the gravel field in 8 different positions by making two such corners in each of the four corners of the field.

Four systems of drill-hole spacing were used, beginning with 23 holes and increasing to 181, or slightly less than 2 holes per acre. The enriched areas varied in size from 0.07 up to 1¼ acres. In the first field the number of these spots was 44; in the second field, 29.

If a drill hole entered an enriched portion of the field, it was tabulated as a hit; if on the line bounding such an area, it was counted as one-half a hit.

Heavy Mountain Transportation

The transportation of sectionalized machinery over mountainous country is slow and difficult. This is accomplished in the North in the following manner: Sleds are constructed of timber upon which the sections are securely lashed. These sleds are made of 12x12-in. timbers with the ends hewed to assist in surmounting obstacles, a flooring of 2-in. planks covering these runners and serving as a platform for the machinery. Flywheels come in two parts and one part is put on each sled. Crankshafts, hoisting drums, etc., are fitted similarly. A stationary hoist engine of the type used by contractors is mounted on a sled and this train of engine and trailers is hooked together. A cable is carried ahead to a firm hold on a tree. Water connections are made from a 1-in. pipe from the nearest brook above and a trail is cleared sufficiently to permit the passage of the train. The engine is started and the cable winds up on the drum, thus pulling the train along. If the grade is too steep for the entire train, the remainder of the sleds are hauled up with the cable after the engine has reached the end of its haul. Blocks are sometimes used to give greater leverage to pull the entire train at once if this method is thought to be easier than breaking the train up. When the anchorage has been reached the cable is carried ahead and the operation is repeated. One thousand feet is about the limit of a stage in heavy country. Rough wooden timbers are used for idlers when these are considered necessary.



SKETCH OF GRAVEL FIELD AND DRILLING PLANS

System A left the holes 400 ft. apart, but increased the interval between rows to 400 ft., and the holes were staggered. The resulting maximum error in 16 applications of the drill holes to the field was 28.6% and the average error was 8.05%. Using system B, 12 trials showed a maximum error of 18.1% and an average error of 8%. This system consisted of 400-ft. spacing of holes and rows 200 ft. apart with holes staggered. Using system C, with holes and rows each 200 ft. apart and holes staggered, the maximum error in 12 trials was 12% and the average error for the 12 trials was 5.17%. Using D system, with holes 200 ft. apart and rows 100 ft. apart, staggered, the maximum error obtained in 16 trials was 7% and the average error using the first field was 3.58%, while with the second field it was 2.78%.

Details of Milling and Smelting

Metallurgical Experiments at Santa Gertrudis Mill*

Upon the publication of results obtained at Nipissing with desulphurization and aluminum-dust precipitation, similar experiments were undertaken at the Santa Gertrudis mill, Pachuca, Mexico, by A. W. Hahn. Desulphurization, as was to be expected, gave no beneficial results on the ore, which contains no tellurides, arsenides, etc. On the other hand, aluminum-dust precipitation showed a considerable improvement over the zinc-dust method, and its adoption has only been delayed by war conditions that have practically put aluminum dust off the market. Comparison of the two methods was based upon normal prices of aluminum and zinc dust—30c. and 7c. per lb. respectively.

As practically all the existing equipment can be used conveniently in the aluminum-dust process, the problem as worked depends for commercial success upon an economical method of converting the lime in solution, and that added during milling for neutralizing and settling, into calcium carbonate with the formation of the necessary caustic soda as a product of this reaction, all prior to precipitation by aluminum dust. Any lime present in solution during precipitation will be converted to calcium aluminate, lowering the grade of the precipitate and causing difficulty in melting. The conversion and elimination of lime can be accomplished by the addition of carbonate or bicarbonate of soda, as follows:[1]

$$Ca(OH)_2 + Na_2CO_3 = Ca\,CO_3 + 2NaOH$$

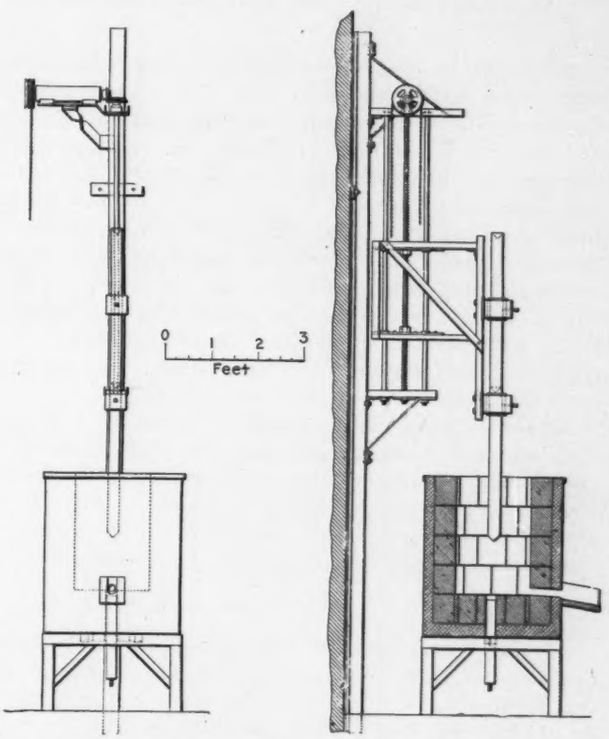
$$Ca(OH)_2 + NaHCO_3 = Ca\,CO_3 + NaOH + H_2O$$

In place of commercial carbonate or bicarbonate of soda, laboratory tests showed the probable successful use of an impure local product know as *tequesquite,* obtained from the dried-up bed of Lake Texcoco and containing approximately 56% carbonate and bicarbonate of soda in about equal quantities. In practice the *tequesquite* solution would be added to the pulp flowing to the collecting tanks above the Merrill filter presses. In experimental work the aluminum-dust precipitate yields a bullion 975 fine. The consumption of aluminum dust was about one-third that of zinc dust, or 0.34 oz. to 1 oz. fine bullion. The slightly increased cost, per ton of ore, of aluminum dust is more than offset by decreased chemical consumption of cyanide, the net saving being calculated at $0.15 per ton of ore.

Electrolytic Regeneration of Cyanide

Prior to the favorable conclusions reached in the aluminum-dust tests, a lengthy investigation was conducted on the regeneration of cyanide in the mill solution by electrolysis. Anything like a comprehensive description of this interesting work cannot be taken up here, and only the important features will be outlined.

The principal difficulty presented was in finding an anode of high conductivity that would not dissolve or disintegrate. Graphite, lead, plumbago, carbon, charcoal, magnetite and peroxidized lead were tried without much success. An alloy of lead with 6 to 9% of antimony was selected as fairly satisfactory in filling the requirements. The following conclusions were then worked out:



ELECTRIC FURNACE AT SANTA GERTRUDIS MILL

The solution to be treated by electrolysis must be barren of gold and silver to avoid their precipitation. The question of enlarging the scope of the process to include electrolytic precipitation of these values was also investigated separately. The regeneration of cyanide takes place at the cathode, with a destruction of cyanide at the anode which may be principally overcome by maintaining a high protective alkalinity at the anode. A porous diaphragm, such as canvas, separating the anode and cathode, assists in maintaining an alkaline anolyte, circulation of anolyte and catholyte being accomplished individually. Power consumption is affected by resistance of electrodes, electrolyte and diaphragm, by temperature and circulation rate of electrolyte and by spacing of electrodes.

The voltage drop per cell, at a current density of 15 amp. per sq.ft. of anode surface, treating barren solution containing 0.5% total KCN and 0.115% CaO, with canvas diaphragm and electrodes spaced 1½ in. apart,

*From an article by Hugh Rose in August, 1916, Bulletin A. I. M. E.

[1]For chemistry and details of aluminum-dust process refer to: "Aluminum Dust Precipitation at Nipissing," E. M. Hamilton, "Eng. and Min. Journ.," Vol. 95, No. 19, and Vol. 99, No. 13; "Aluminum Precipitation at Deloro, Ont.," S. F. Kirkpatrick. "Eng. and Min. Journ., Vol. 95, No. 26; "Nipissing Mill and Metallurgical Practice," James Johnston, Bull. A. I. M. E., 95; "The Mill and Metallurgical Practice of the Nipissing Mining Co.," G. H. Clevenger, A. I. M. E., July, 1914.

is 6 volts at 70° F., under which conditions the solution flow should be at least 0.25 gal. per sq.ft. of anode surface. The deposit on the cathode analyzed 71% zinc, with impurities of copper, iron, arsenic and organic matter. The recovery of this zinc might be turned to some commercial advantage. The reaction representing the regeneration of cyanide is presumably as follows:

$$Na_2Zn(CN)_4 + Ca(OH)_2 + \text{Current} = 2NaCN + Ca(CN)_2 + Zn + H_2O + O.$$

The net reduction of cost was estimated at $0.12 per ton of ore. The equipment outlay, however, proved to be several times greater than that required to convert the precipitation plant to the use of aluminum dust, and as the latter process at the same time indicated a somewhat larger cost reduction without further complexities of plant, its adoption in place of regeneration was decided upon.

Electrolytic Precipitation, Regeneration and Refining

Following the experience gained in the experiments with regeneration, the next step was to endeavor to combine with it the electrolytic precipitation of gold and silver from solution. Difficulty was encountered in obtaining a coherent cathode deposit. It was found uneconomical to attempt a complete precipitation, the limit of commercial work being about 1.3 oz. silver remaining in solution. Plant cost would be high. Altogether the proposition did not present sufficiently attractive possibilities to warrant following it up thoroughly. With the perfection of the diaphragm cell it is probable that both precipitation and regeneration electrolytically could be worked out to a fair success.

A preliminary investigation has been made of electrolytic refining of precipitate from the present zinc-dust installation. The chief difficulties to be overcome are resistance of the precipitate to the current, purification of the electrolyte, high acid consumption due to impurities, and refining and melting of the gold slime.

Tests on Flotation Concentration

As previously stated, the ore is clean with only small quantities of base metals. A representative analysis is: Au, 0.067 oz.; Ag, 12.0 oz.; Pb, 0.10%; Cu, 0.20%; Zn, 0.15%; Fe, 4.40%; SiO_2, 86.67%; S, 1.00%.

Most of the silver value is present as argentite, Ag_2S, about 0.05%. It is therefore evident that little benefit in recovery is to be expected by water concentration. At the time of building the plant complete experiments were conducted on a working scale, the recovery by concentration representing from 8 to 10% of the value of the ore. This did not justify the installation of water-concentrating equipment plus added cost of operation as against direct cyaniding. The growing success of flotation concentration in the United States led naturally to local investigation of the problem which, though still in the laboratory stage, already shows encouraging results. If the process is worked out to a commercial success, a detailed description of results should be of interest. Meanwhile a summary of preliminary conclusions is given as an indication of possibilities.

A large variety of vegetable and mineral oils have been tested, the best results thus far having been obtained with one-third pine oil or wood creosote and two-thirds Mexican gas oil, such as is used locally in the oil-fired melting furnaces. The pine oils and wood creosote tried are imported, but doubtless satisfactory substitutes can be made near at hand. Several coal tars and a number of Mexican oil-field products remain to be tested. The addition of acid shows no particular benefit. A slight alkalinity, not exceeding 0.03 lb. lime per ton solution, is satisfactory. Heating the solution does not materially improve results. The flotation tailings are cyanided readily, the presence of the small quantity of oil having no deleterious effect.

Possibility of Replacing Cyaniding by Flotation Process

The raw flotation concentrates cyanide with no more difficulty than water concentrates, the cyanide consumption maintains more or less the same ratio as in the crude ore—4 grams sodium cyanide per gram silver. A 98% extraction of gold and silver in the concentrates is obtainable. In the small laboratory machines, without cleaning cells a recovery by flotation of 65 to 70% can be made at a ratio of concentration of between 80 and 90 to 1. In the 100-ton trial plant now under construction equipped with middlings return and cleaning cell, it is expected that these results can be improved. It is possible, though not certain, that flotation even with this clean ore, may replace cyanidation to a large extent.

Melting the precipitate in an electric furnace built after the Alaska-Treadwell design is under trial. Alternating current at 120 volts is used, the input being about 600 amp. working at full heat. Trouble has been experienced with dusting and with burning a hole through the bottom of the furnace. A renewable iron plug may provide a convenient remedy for the latter. The dusting is probably due to the precipitate being wet, the intense heat at the electrode setting up a center draft of steam and air. Either the precipitate should be dried or some dust-collecting apparatus attached to the furnace top. The advantages of this system over the oil-fired crucible method of melting are rapidity of melting and discontinuance of use of crucibles and oil, both of which require a long-distance haul. No data are available yet as to the comparative economy, but further investigations will be made of the subject.

Platteville District Milling

The zinc and lead output of the Wisconsin-Illinois-Iowa district is the product of about 65 concentrating plants having a milling capacity of from 7,130 to 12,000 tons daily, depending on the grade of ore handled. The lower figure of 7,130 tons is based upon the former method of rating a mill treating rich culled ore running 20% blende. Thus the standard 75-20 mill of former days meant one guaranteed to handle 75 tons of 20% blende ore in 10 hours. Such a mill had one rougher jig of 7 cells, each 40x30 in., and one cleaner jig of 7 cells, each 36x30 in. Such a standard mill treats the lower grade ores milled today with greater capacity per day, handling approximately 125 tons daily of dirt running 1 to 3% sulphides. On the basis of the lower-grade ore now mined the capacity of these plants is about 12,000 tons daily.

While it is probably unfair to compare the mills of this district with those of the Missouri districts, it is interesting to note that those of the latter comprise about 134 plants having a daily capacity of 29,900 tons.

The Argonaut Mine, Calif.

By Lewis H. Eddy*

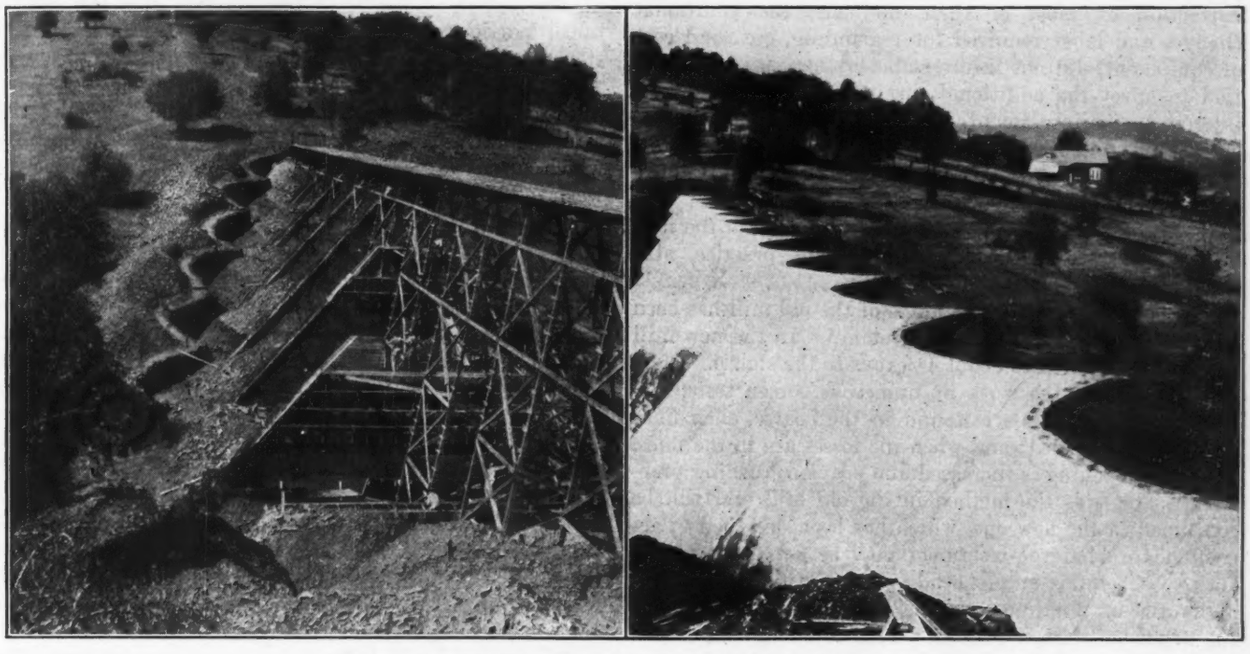
SYNOPSIS—Apex litigation having been disposed of, improvements are being installed. The old mill is being replaced by a 60-stamp mill. Arrangements are being made for impounding the tailings by means of an Eastwood multiple-arch dam. Hoisting and pumping facilities are being greatly increased to accommodate the increased production.

Two years ago the *Journal* published an article detailing briefly the plans then contemplated by the Argonaut Mining Co. at Jackson, Amador County, Calif., for remodeling and increasing the capacity of the 40-stamp mill and the installation of a gravity system for disposing of tailings.[1] At that time the apex suit of the Kennedy Extension Gold Mining Co. vs. the Argonaut Mining Co. was pending in the Superior Court. On June 29, 1914, Judge Fred V. Wood, without a jury, rendered decision that the continuity and identity of the Argonaut vein was sufficiently shown to meet the requirements of the law.[2] Subsequently the case was kept out of the Supreme Court, and early in the present year the differences between the plaintiff and defendant were settled out of court and the Argonaut company came into possession of the Muldoon mine, in which the Kennedy Extension claimed that the Argonaut vein apexed.

The development of plans and further preparations for reconstruction of the mill and installation of tailings plant have been in progress during this period, and at the time of my last visit to the Argonaut, at the beginning of April, 1916, the work was well under way. The installation of an underground hoist on the 3,900-ft. level had just been completed and started operation. Construction of a gravity system for disposing of tailings, including an Eastwood dam for conservation, was in progress. The plans contemplated in 1914 for improving the milling plant had been elaborated, and it was decided to rebuild the 40-stamp mill and add 20 stamps to it and to begin reconstruction about the first of May. The installation of electric pumps and the exploration of new ground were also arranged for.

In order economically to carry the tailings from the mill to the storage ground, it was deemed necessary to change the situation of the mill; and as the increased capacity will necessitate additional and new metallurgical appliances, the installation will be practically a new mill, using some of the old parts and stamps that are still serviceable. The old mill was used for about 18 years without extensive repairs. It was badly worn out, and the time had come when the whole mill would have to be generally overhauled. The old mill site was inadequate for an increase in capacity, and rather than install an expensive tailings-elevating system or move the old mill to the new site, it was decided to reconstruct and practically build a new mill. The elevation of the new mill above the present shaft collar will necessitate raising the ore a farther distance of about 225 ft. to the new mill bins. The new mill is 800 ft. west of the old mill site. Construction started the first week in May, all labor and material being supplied under contract. The main machinery parts are built by the Knight foundry at Sutter Creek.

N. S. Kelsey, mine manager, said that after extensive and thorough examination and experimenting with other processes, it had been decided to stick pretty close to the



THE EASTWOOD MULTIPLE-ARCH TAILINGS DAM

*Associate editor, 3430 Peralta St., Oakland, Calif.

[1] "Eng. and Min. Journal," Feb. 14, 1914, p. 380.

[2] "Eng. and Min. Journal," July 18, 1914, p. 100.

present metallurgical practice of stamping, inside and outside amalgamation and concentration. The mill will be equipped with thirty-six 6-ft. vanners of Allis-Chalmers make; 4 Darrow multiple-deck buddles, 3 of which will be used for treating the slimes, and the product from these 3 buddles will be recleaned on the fourth and smaller buddle. By this process it is expected to get a shipping product from the slimes. One or two tables may be put in for cleaning some of the slimes. So the only changes made in the practice of the past are along the lines of classifying. Each five stamps is provided with separate classifiers so that each forms a separate unit. The feed to the first two rows of tables will be the coarse from the classifiers; the fines from the classifiers will go to Callow tanks to be thickened before feeding onto the third row of tables. The classifiers are merely home-made V-boxes. The vanners are set in 3 rows of 12 machines each.

Experiments with Flotation and Other Methods

Before deciding on this final arrangement, the Argonaut management spent a good many thousand dollars and much time experimenting with cyanidation, regrinding, amalgamation and re-treating and did some extensive experimenting in flotation. While able to better the past extraction by most of these methods, the additional changes and labor required for regrinding, etc., and cost of equipment, did not insure sufficient increase in extraction to offset the additional cost and to pay reasonable interest on the investment. Mr. Kelsey said that the best extraction was obtained by flotation. The Argonaut mill has been getting 70% of its total extraction by amalgamation, and when contemplating other methods that have been tried, including cyaniding, it was with the idea of adding these methods to the present practice, still retaining amalgamation.

The past duty of the 40 stamps of the old mill has been at the rate of 5 tons per day per stamp. In the new mill this will be reduced to about 4½ tons to the stamp. Close track is kept of the work by numerous screen tests, and when the greatest loss is found in the coarse, then finer screens are provided; and when the losses are in the fines, the screen opening is increased and coarser crushing practiced. This was the method in the old mill and will be continued in the new one, which has been designed to accommodate whatever treatment may be developed in the future. There is ample headroom to install regrinding apparatus or flotation machinery if the time comes for the adoption of such process. This could not have been done in the old mill for lack of headroom. All elevation in the new mill, after the final elevation of the ore to the bins, will be eliminated. At the headframe of the shaft two large Blake-type crushers are installed, and the ore will all be crushed to pass a 1½-in. ring. Each one of the crushers will be of sufficient capacity to crush all the ore, so that when there is dry ore, one crusher can be held in reserve against the time when there is wet, sticky and gougy ore, and still crush fine by using both instead of one crusher.

The grizzly capacity is increased, reducing the amount of material that is passed through the crusher. This material will all drop into the bin at the headframe, from which the incline-tramway skips will be loaded and the ore will be hoisted in balance into the mill bins. The elevation of the dumps of these skips over the mill bins will be sufficient to provide for making a distribution of ore in the mill bins by a system of chutes and slides and the use of triangular cones or deflecting baffles. This will give a uniform distribution of the coarse and the fine.

The increased capacity of the mill necessitated provision for largely increased storage for tailings. It is also necessary for all the Mother Lode mines in Amador County to meet the requirements imposed by the courts on behalf of the farmers on the several creek bottoms. The Argonaut owns sufficient acreage of land of ideal topography for just such storage basin and for conservation of tailings for future re-treatment.

The new Eastwood multiple-arch dam is 420 ft. long and 46 ft. high at the highest point, ranging in thickness from 30 in. at the base to 12 in. at the top; 13 full arches with bases on the end. It is estimated that 25 years' storage capacity for tailings from 40 stamps, crushing a total of 200 tons per day, will be provided. The tonnage will be increased to nearly 300 tons a day by the addition of 20 stamps to the mill and thus reduce the life of the storage; but the dam can be raised to accommodate the additional demand, as the construction is in such form as to allow a raise of 30 ft. above the present height. During the first few years the storage will fill up the bottom of the basin very quickly, and the last or upper portions of the basin will really give the longest storage. This arch type of dam is approved by the California state engineering department. It has the best possible foundation, made of concrete, the material being obtained locally from the dumps of hydraulic diggings, which supply large amounts of gravel from ancient river wash. The gravel is screened, washed and crushed.

Reinforced with Hoist Cable

In the arch type of dam it is possible to use hinged joints where the arches meet, but in the construction of the Argonaut dam the hinge is not used. The concrete was poured solid instead of hinging, full account being taken of stresses from slime and water. A 1⅛-in. hoisting cable is used for reinforcing the concrete by passing it through the arches. Engineers claim that old cable is as good as new after the excess grease has been cleaned off and will serve as good purpose as iron bars, because the stretch has been taken out and the little grease that is left in an old cable will not interfere with the concrete. The dam will be completely finished before any water or tailings are turned in, so that the concrete will have ample time to set.

The storage basin is formed of two large ravines. The watershed is not extensive, but in the season of rains a large volume of water comes through the ravines, so it will be necessary to put in a fairly elaborate system of laterals to bypass this flood water; otherwise the storage would be decreased by the débris washed into the basin behind the dam. A simple spillway is provided at the end of the dam. The impounded tailings will some day be an asset and by this system of storage will be available for re-treatment. The construction work was done under contract by Bent Bros., of Los Angeles. The plans and specifications were provided by John S. Eastwood, of San Francisco. The estimated total cost of the dam was $23,000.

The main Argonaut shaft is 4,485 ft. deep, inclined 65° east, down to the 4,350 level. Between the 4,050 level and the 3,900 the hoist is connected with the main shaft on an easy curve. This short section of shaft lies in

the hanging wall of the main shaft. The new hoist installed on the 3,900 level is practically a duplicate of the surface hoist and was built by the Knight foundry at Sutter Creek. The gears are cut steel, helical-type, built by the Falk Co., Milwaukee, Wis. The rope transmission, motor drive, is built by Meese & Gottfried, San Francisco. A 225-hp. Westinghouse motor is used. A number of improvements over the surface hoist have been made in the way of reinforcing some of the parts in the new hoist found to be weak in the old one. The new one is also heavier than the old. Replacement has also been made in the surface hoist. The plant is now sufficient to warrant the deepening of the shaft 3,000 ft., which will make a total incline depth of 7,000 ft., or a vertical depth of more than 6,000 ft.

The skips coming up through the lower section of the shaft will be emptied into a large-capacity ore pocket at the 3,900 level, and the ore as needed will be drawn off from this pocket into the skips in the main shaft. In the past the Argonaut has been hoisting waste to the surface during shaft sinking. A crosscut has just been completed from the main vein, which taps the bottom of the waste shoot at the 3,900 level, so that in the future the waste from sinking will be hoisted only to the 3,900 level and then trammed back through the crosscut and dumped into the stope raise which will be maintained as the levels go down. The new hoist, if used only for handling stope filling, will save the expense of hoisting the further distance of 3,900 ft. to the surface and so make economic use of the waste.

One of the principal reasons for installing the underground hoist is that the shaft in the old upper portion is crooked, and a rope larger than 1⅛ in. diameter, carrying the requisite factor of safety for greater depth, cannot be made to run on the shaft idlers. Another reason is that for hoisting from a greater depth a larger and differently designed hoist would have to replace the present surface hoist. For these reasons hoisting in relay has proved the most economical for the present.

Two Deane Vertical Power Pumps Installed

In past years the water hoisted from the Kennedy mine adjoining the Argonaut on the north has drained the latter. The Kennedy has been very much deeper and consequently has kept the water drained ahead of Argonaut development. But the Argonaut having a shorter oreshoot, has been obliged to go down faster than the Kennedy, until now the Argonaut shaft is practically at the same vertical depth and will soon be at a greater depth than Kennedy. The result is that the Argonaut is getting more of its just portion of the water and before many years will be draining the Kennedy ground. The water has increased rapidly in the last year or two, and the Argonaut has been hoisting 1½ skips of water to every skip of ore and waste.

The contemplated increase of mill capacity has brought development to the point where the water must be taken care of by pumping equipment instead of skip hoisting. So at the time of my visit, the company was preparing to install pumps to handle the water. As soon as this installation is completed, the hoist will be relieved of hoisting water and able to handle a greater tonnage of ore. The pump installation includes two 4½x12-in. Deane vertical single-acting triplex power pumps. Gears are double-helical type. The pumps have extended motor base; are direct connected to 75-hp. Westinghouse three-phase, 2,200-volt 60-cycle motor of 585 r.p.m. The two pumps will be used to raise the water in two lifts through a 5-in. discharge column. The discharge from the pump at the 3,900 station will flow into a large tank on the 2,000 level. So there will be two complete units or two separate sections so far as the pumps are concerned. These pumps will be capable of handling 65,000 gal. of water per 8 hr.

The Argonaut now has south of the oreshoot a large amount of territory which remains unexplored owing to the congested condition of the working shaft and to the apex litigation. Installation of pumps will provide relief from hoisting water, which will give opportunity to run out to the south and explore this territory. The first exploration will probably be started from the 3,900 level by means of a long hanging-wall drift to the south, with numerous crosscuts to the vein opening. This work will be done as room is made in the stopes for the spoil broken, which will be used for filling. The company is rushing work on the second exit to connect with the surface in order to fully comply with the law covering second exit in deep mines and also to provide better and natural ventilation. This second exit, will be at the south through the old Muldoon shaft and through a series of raises that are being carried in the south end of the mine.

National Engineer Reserve

In a circular letter recently issued by the Joint Committee of the Engineering Societies, it is reported that its desired legislation was embodied in the Army Reorganization Act of 1916, passed by Congress, and effective July 1, 1916.

This bill contained provisions for the organization of an Officers Reserve, including engineers. The War Department will soon issue an invitation to the engineers of the country to apply for commissions in the Reserve Corps of Engineers. Information will then be available as to the requirements for commissions graded from second lieutenant to major and the method of procedure necessary to secure commissions.

The following is a brief abstract of the Act relating to the Officers Reserve:

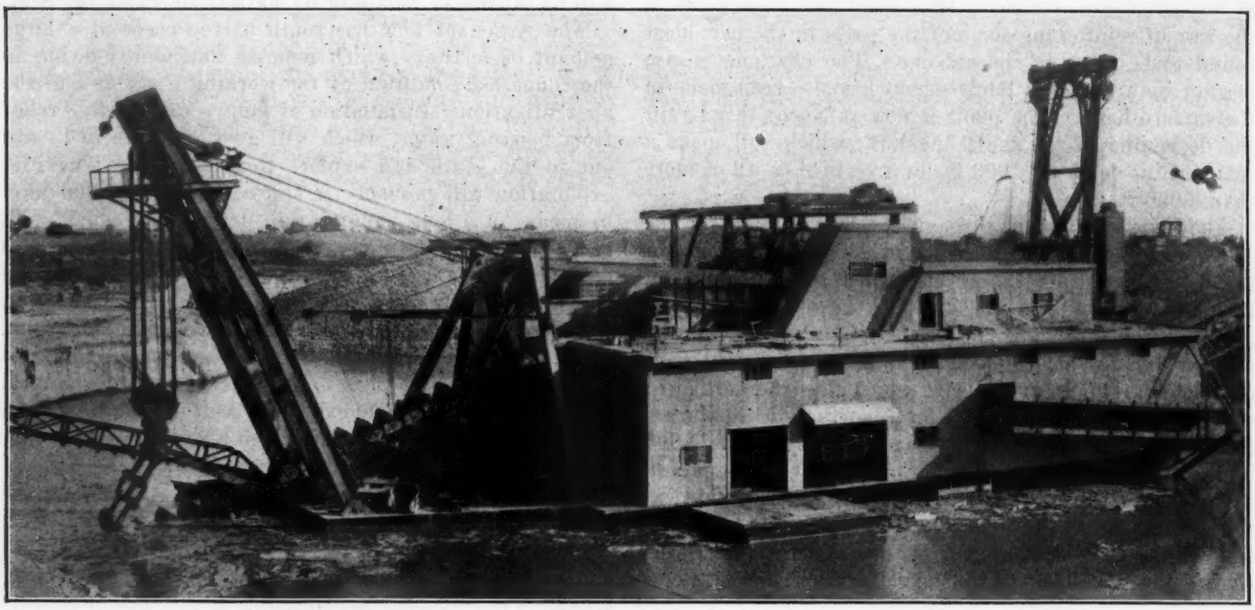
For the purpose of securing a reserve of officers available for service as temporary officers in the regular army . . . there shall be organized an Officers Reserve Corps of the regular army. The corps shall consist of sections corresponding to the various arms, staff corps, and departments of the regulars. A member of the Officers Reserve Corps shall not be subject to call for service in time of peace.

The President alone is authorized to appoint and commission the officers in the various sections of the reserve corps. Commissions shall be in force for 5 years unless sooner terminated at the discretion of the President.

In time of threatened or actual hostilities, the President may order members of the Officers Reserve Corps to temporary duty with the regular army in grades which cannot for the time being be filled by promotion or to duty as officers in volunteer or other organizations.

The Secretary of War is authorized to order reserve officers to duty with troops for field exercises or for instruction, for periods not exceeding 15 days in one calendar year during which such officers will receive the pay and allowances of their respective grades in the regular army.

Photographs from the Field



MARIGOLD NO. 5 DREDGE DIGGING IN THE YUBA BASIN FIELD, CALIFORNIA

This new 16-cu.ft. dredge of the Marysville Dredging Co. began operating May 7, 1916, construction having been started Dec. 27, 1915. It is an all-steel dredge, designed to dig 70 ft. below water level and a bank 20 ft. above. It was built by the Union Iron Works Co. and contains a number of new features. Total weight is over 2,000 tons, and the cost of the dredge over $400,000

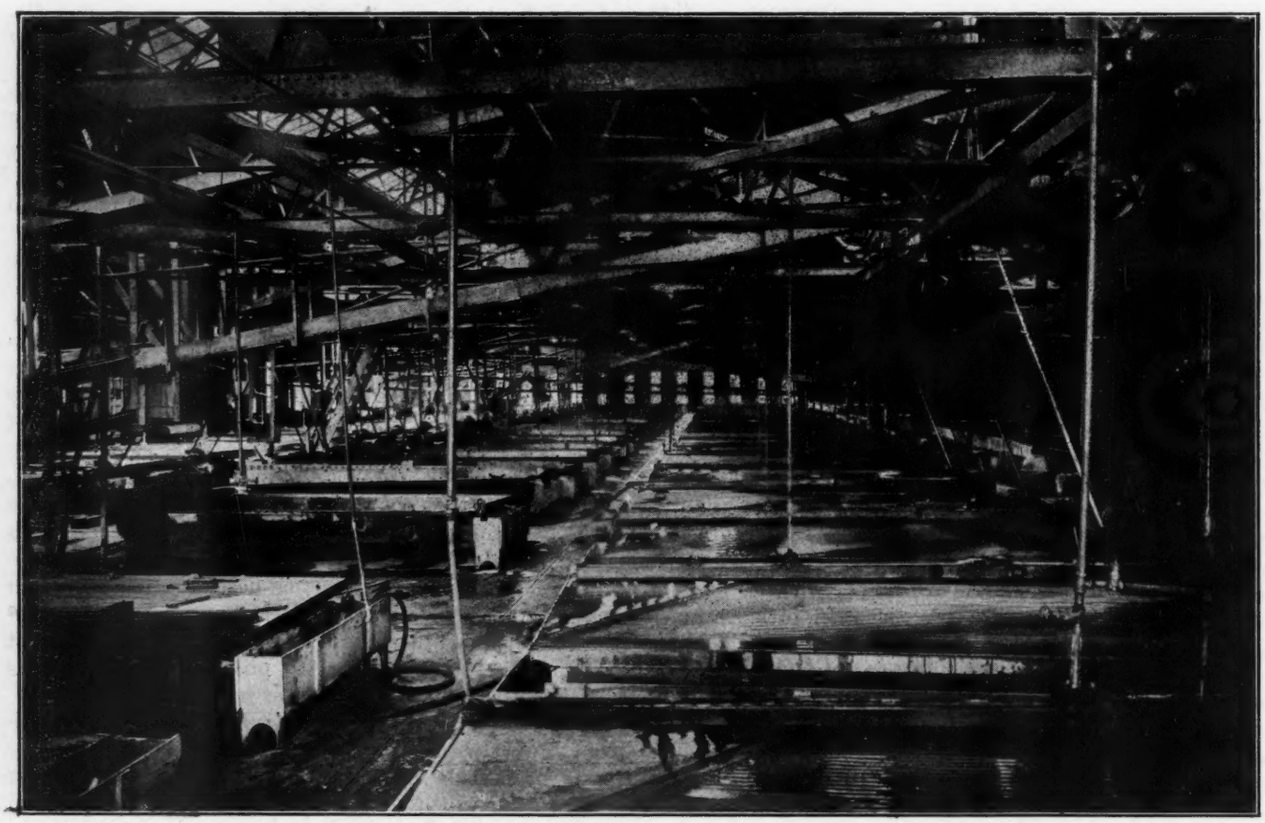
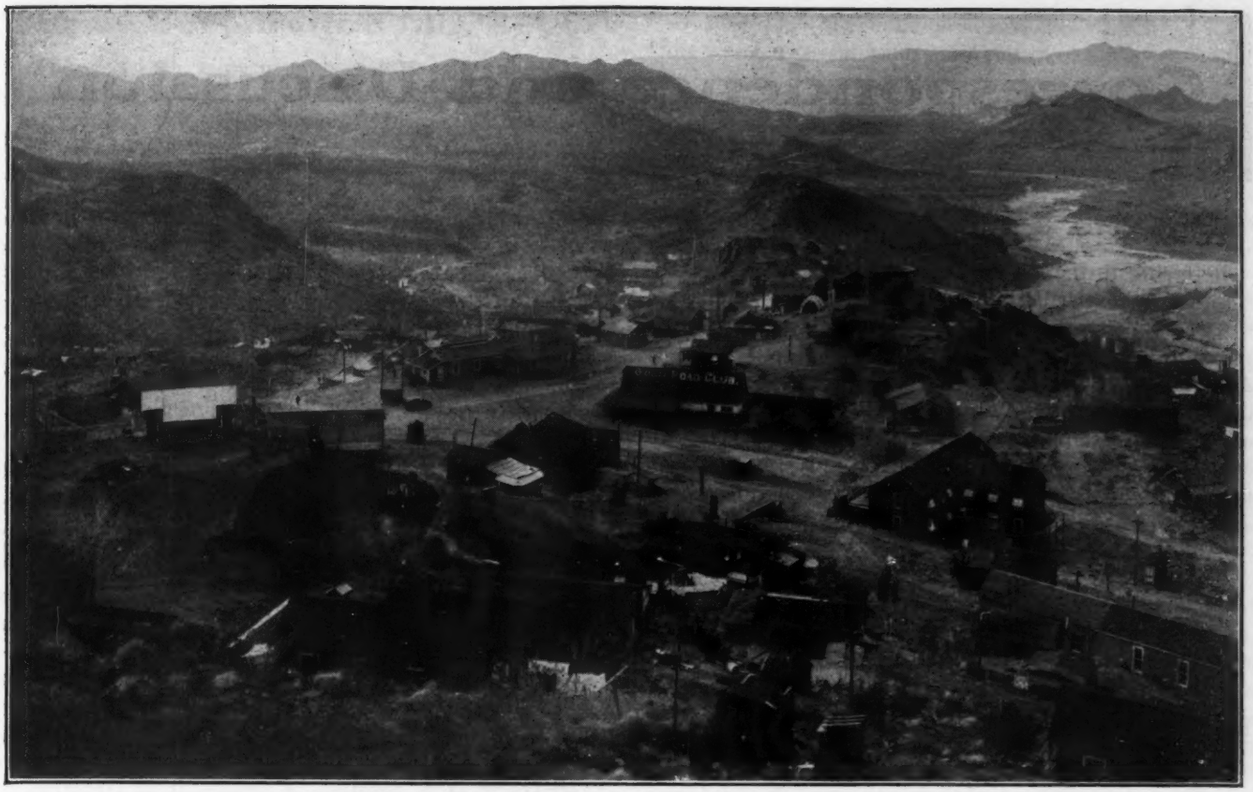
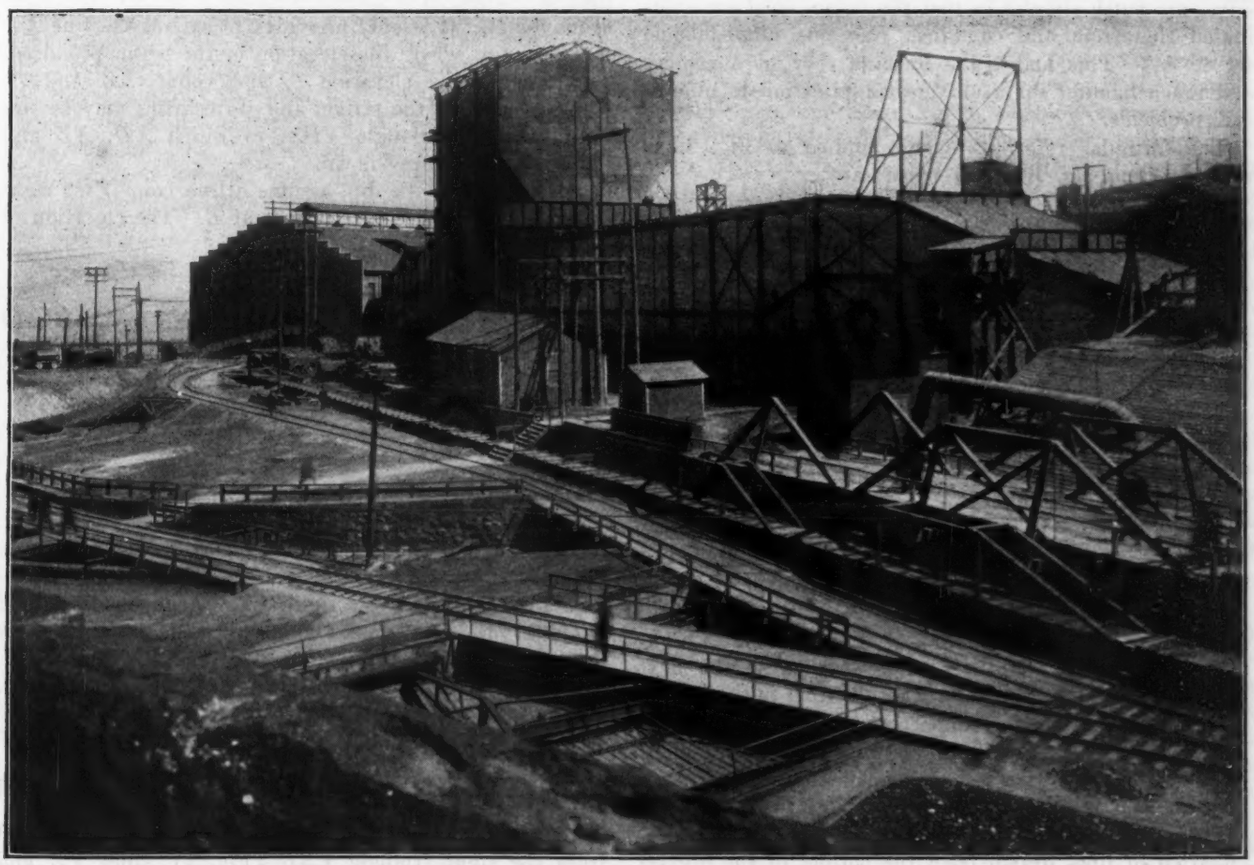


TABLE FLOOR IN THE FEDERAL LEAD CO.'S MILL, FLAT RIVER, MO



THE TOWN OF GOLDROAD IN MOHAVE COUNTY, ARIZONA, ABOUT ONE MILE FROM OATMAN



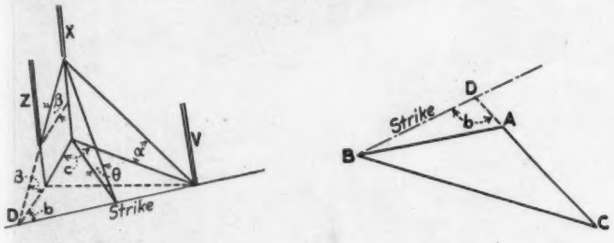
COTTRELL PRECIPITATION PLANT ON NO. 2 ROASTER FLUE AT ANACONDA, MONT.

Notwithstanding that the courts relieved Anaconda of the charge that important damage was being done to the agricultural interests in Deer Lodge County, the company is continuing to spend a large amount of money on the elimination of any possible smoke nuisance

Correspondence and Discussion

Dip and Strike Calculations

Referring to the article entitled "Dip and Strike Calculations from Drill-Hole Data," by George E. Burton, in the *Journal* of July 15, I wish to call attention to a paper dealing with the same subject in the *Journal* of Apr. 11, 1914. The final equation for the angle which, in combination with one of the given bearings, gives the strike of the vein, may in the last analysis be considered analogous in both papers. It would seem, however, that not only is the derivation of the equation in my



DIP AND STRIKE CALCULATIONS

solution infinitely simpler, but the final formulas themselves are much simpler in that the values *abcd* are eliminated therefrom and combined into one unmistakable term "*m*." This makes the formula easy to remember and much handier for a universal application to numerical problems.

The formulas referred to and applied to Fig. 1, as adopted from Mr. Burton's paper, are:

$$Tan\ b = \frac{sin\ n}{m + cos\ n} \qquad (1)$$

in which $m = \frac{tan\ a}{tan\ \beta}$ and $n = (180° - c)$.

If it is preferred to use angle c directly, the formula is

$$Tan\ b = \frac{m - cos\ c}{sin\ c} \qquad (2)$$

My formula for the angle of dip is

$$Tan\ \theta = \frac{tan\ \beta}{sin\ b} \qquad (3)$$

To apply the formulas to a numerical problem:

Draw any irregular triangle, *ABC*, Fig. 2, assuming, for instance, *C* to be the bore hole whose bottom is highest, *A* to be the bore hole whose bottom is the next highest, *B* to be the bore hole whose bottom is the lowest. Always produce the line connecting the highest with the next highest hole (*CA* in the assumed case) to a point *D* and connect *D* with remaining hole (*B* in our case). The angle *b* is always at this point *D;* the angle β is always the adjoining, and a the opposite angle of inclination of lines drawn from the bottom of the highest to the bottom of the other two holes. Angle *c* is always the surveyed horizontal angle at the highest bore hole. This is all there is to be remembered in my formulas, whereas in Mr. Burton's the relative position in space as well as the respective meaning of the distances *abcd* and that of the angles *S* and *e* would have to be remembered in order to apply these values correctly in a numerical problem.

The much quicker graphical solution in my paper will usually give results sufficiently accurate for all practical problems.

THEODORE SIMONS.

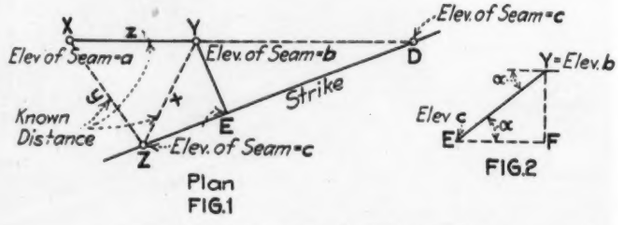
Butte, Mont., July 20, 1916.

Dip and Strike Calculations

In the *Journal* of July 15, in an article by George E. Burton, entitled "Dip and Strike Calculations from Drill-Hole Data," it seems to me that his solution is unnecessarily long and cumbersome. A simpler solution would be as follows:

In the diagram, suppose three drill holes, *X, Y* and *Z*. Of these, *X* strikes the ore (or rock) at an elevation *a*, *Y* strikes it at *b* elevation, *Z* strikes it at elevation *c*. Supose *c* elevation is the lowest and that *b* is lower than *a*. Then in a known distance *z* or *XY* the seam drops *b-a* ft. It is only necessary to extend the line *XY* to *D*, a point where the elevation of the seam, produced, would equal the elevation *c*, and connect *Z* and *D*. This line *ZD* is the strike, and its bearing may be figured from the triangle *XDZ*, in which *XD, XZ* and the angle *YXZ* are known.

To deteremine the dip, assume a line from *Y* at right angles to *ZD* and intersecting it at *E*. The clevation of



DIP AND STRIKE CALCULATIONS

the seam at *E* is the same as at *Z* and *D*, since it intersects the line of strike between *Z* and *D*. The line *YE* represents the hypotenuse of a right triangle, since it lies along the dip. In the second diagram *YF* is the difference in elevation between the seam at *Y* and the seam at *E*, or *c-b*. *EF* is the actual distance on the diagram at Fig. 1 represented by *YE*, since it is the projection of *YE* on the horizontal plane. Since (Fig. 2) *YF* and *EF* are both known, $\tan a = \frac{YF}{EF}$ = angle of dip. The actual distance *YE* on Fig. 1 (*EF* on Fig. 2) may be figured from the right triangle *YZE* (Fig. 1), since *YZ* and the angles *YZE* and *EYZ* are known.

Negaunee, Mich., July 19, 1916. J. F. HANST.

Burma Corporation Ltd. Report

The Bawdwin mine of upper Burma is probably the greatest body of silver-lead-zinc ore whose exploitation has been successfully consummated in the last decade. At a recent London meeting of the Burma Corporation Ltd., Theodore Hoover made a report on the progress made in the past six months, the outstanding features of which follow:

Begun in April, 1914, and driven by hand labor for eight months, the Tiger tunnel heading advanced at the rate of 100 ft. per month. Upon installing mechanical equipment in January, 1915, the rate of progress for the 12 months following was 250 ft. per month working from one heading only. Since the completion of an internal shaft down to the tunnel level in January, 1916, work has progressed at the rate of 440 ft. per month working from two headings. With only 910 ft. to drive the completion of the tunnel is now expected in September.

In the years past, the smelter has been employed largely upon old Chinese slag using only about 10% mine ore with 90% slag. With the approaching exhaustion of this slag, however, the proportion of mine ore in the charge has been increased to 50% in recent months, without any disastrous decrease in the amount of metal produced.

During the last six months reported 1,000 ft. of drift, 1,150 ft. of crosscuts, and 400 ft. of raises have been driven. As a result of this work the orebody has been increased on the third level to an area of 67,700 sq.ft., on the fourth level to 72,100 sq.ft., and on the sixth level to 3,900 sq.ft. One of the crosscuts on the third level shows a phenomenal width of 136 ft. of high-grade ore.

This development has increased the proved ore by 350,000 tons bringing the total to 2,085,000 tons, and increased the probable ore by 200,000 tons making the total 765,000 tons. Anticipated, or speculative, ore is now placed at 650,000 tons, thus bringing the probable total in the mine above the Tiger tunnel level to 3,500,000 tons.

Remarkably High-Grade Orebody

An inner core of the orebody above delineated is described as a phenomenal high-grade body 750 ft. long and 35 ft. wide on the third level, which assays 33 oz. silver, 37% lead and 23% zinc, or 60% solid metal. On the fourth level its dimensions are 850 ft. long, and 45 ft. wide, assaying 42 oz. silver, 42% lead and 24% zinc, or a total of 66% solid metal. These two levels are connected by raises driven all the way in solid ore assaying 44 oz. silver, 41% lead and 26% zinc, or a total of 67% solid metal. It is estimated that this block contains at least 600,000 tons averaging about 37 oz. silver, 40% lead, and 23% zinc, or 60% solid metal.

On the basis of milling experiments so far made, it is estimated that the whole orebody of 3,500,000 tons above the Tiger tunnel will be handled at an average profit of at least £3 per ton totaling between £10,000,000 and £12,000,000.

A plant for the treatment of 1,000 tons of ore per day is now being designed, and when finished it should show a profit of at least £1,000,000 per annum. Additional capital to the extent of £200,000 is necessary to complete this plant and development so far undertaken. The company has £95,000 cash resources uncalled for at the present time.

During 1915 the mine produced 14,000 tons of lead from which was realized a gross return of £325,000. During 1916, the output is expected to be as great as 1915 for which £30 per ton, or £7 more than in 1915, is expected will be realized, increasing the 1915 income by about £100,000. In other words the profits during construction of the new plant are expected to finish paying for it since the present smelter plant will treat 3,000 tons per month of high-grade on which the profit is £4 per ton.

Tungsten in Inyo County, Calif.

The tungsten development and operation at Bishop, Inyo County, has advanced to a point where the camp is no longer a prospect. Two companies are preparing for extraction and milling ore and on a scale that indicates the establishment of a permanent camp. The Standard Tungsten Co., which was practically the pioneer in the field, sold a part of its holdings to the Tungsten Mines Co. and erected a first mill of 50 tons' daily capacity. The company is now adding to the capacity of the mill another 50 tons. Ore has been extracted and milled to the amount of about 200 tons of tungsten concentrates. A. J. Clark is president and L. Porter general manager of this company, which is a close corporation. The Standard mill is equipped with Dodge crushers, Davis rolls and Isbel tables. The ore is extracted by quarrying and will be carried to the mill by an incline surface tramway 1,600 ft. long, being built by Fulton Iron Works, of Los Angeles.

Construction of a Modern Mill

The Tungsten Mines Co. is also a close corporation, of which T. M. Townsend is president, L. L. Stevens, general manager and Cooper Shapley superintendent. This company is building a 300-ton modern mill equipped with Allis-Chalmers rolls. The mill is situated about halfway between the two mine openings. Development is done by tunnels. One of these openings will furnish the first ore that goes to the mill, and a substantial surface track is being constructed for hauling the ore in cars direct from the tunnel, a distance of 700 ft. This track runs across the end of the gulch near the portal of the tunnel and continues along the side of the gulch to the mill. Haulage will be by locomobile engine rigged on a truck constructed at the shops of the company in camp. The tungsten-bearing ore in this camp is a scheelite, which is associated with garnet. The country rock is granitic. The situation is in a narrow cañon locally known as Deep Cañon. At the head of this cañon, or gulch, the formation inclosing the scheelite is exposed by large croppings and in the Standard Co. holdings so boldly exposed that it forms a quarry.

The camp has naturally an aspect of newness, but at the same time a very positive appearance of permanence. The offices and stores and some of the dwellings are neat, portable wooden houses. There are also a number of substantial tents occupied as dwellings. But most of all, the permanent construction and installation of treatment plants and practical methods adopted in mining and extracting the ore are indicative of the purpose of the operators to make the camp a permanent producer of tungsten. The situation is about seven miles west of Bishop. The road to the town is by no means a good one, though sufficient excuse may be offered by the

fact that all the machinery going into the installation of the mills has been wagon- or motor-hauled from Laws, the railroad station on the narrow-gage branch on the Southern Pacific, which runs south from Tonopah Junction to Keeler. Bishop is situated six miles off from the railroad, which is a distinct disadvantage to the town, but since the dependence of the town is largely upon agriculture and horticulture in Owen's Valley, the people of Bishop are not much disposed to grumble about inadequate railroad transportation convenience. The permanent establishment of the Tungsten Mines Co.'s camp will most likely awaken the people of Bishop and Inyo County to the necessity for better wagon roads and more adequate rail transportation.

The Silver Position in China

The position of silver in China has a very strong effect on the market. Concerning it Messrs. Samuel Montagu & Co. write from London as follows:

"The situation of silver at the present time, considered from the point of view of China, is more than usually interesting. The rise in the price to the neighborhood of 37d., which took place in the early part of May, could not fail to affect strongly the trade, prices and currency of that country, all of which depend largely upon the gold value of silver. In the case of so vast an extent of territory as China and one so ill-provided with communications, the influence of silver prices, though sure, can only permeate in a slow fashion, and it is possible that recent sales on Chinese account were set in motion by the rise, even though it occurred 10 weeks ago.

"Another cause of the freedom with which China has sold silver may have been the moratorium proclaimed in that country. A suspension of specie payments would create a fear in the minds of the Chinese, always upon their guard against officialdom, lest their silver treasure might be annexed. Thus a steady flow, as secret as possible, would ensue toward the Treaty Ports. The accumulation of such fresh stocks would naturally provoke sales of silver to India and London.

Possible Export of Silver

"The permanent currency requirements of China, however, must not be overlooked. It is only possible to hazard guesses as to the amount of silver of which China has been relieved during the last year and a half, but without doubt it is extremely large. Shipments to the extent of 8,500,000 taels were made on Russian account in 1915. Assuming a third of that amount to have been remitted in the current year, the total during 18 months would be some 13,000,000 oz. Add to this at least 20,000,000 oz. in sycee or dollars sold to the Indian government, the Indian Bazaars and London, and a total of 33,000,000 oz. is arrived at. No one at all conversant with the currency requirements of China can imagine that that country can dispense with so large an amount of its stock for any great length of time, for in normal times China attracts annually an amount of the world's supplies which compares appreciably with the total lately disgorged.

"Hence, sooner or later, China will have to make good this efflux of specie, and the return of the silver may coincide with an agreement between the provinces recently at variance, and the restoration of public confidence which would follow that event. It should be borne in mind that the extent of the anticipated replacement would depend upon the price of silver. The higher the price the less silver is likely to flow back.

"The rumored loan of £6,000,000 to be made to China by the United States may be remitted partly in silver, though the latter country will endeavor to send as large a proportion as possible in manufactured goods."

A.I.M.E. Tour of Arizona Mines

For the first time in its history, the American Institue of Mining Engineers will hold its meetings within the State of Arizona. A special train will leave New York on Thursday, Sept. 14, at 5:30 p.m., but members and guests may join it at other points en route.

Arrived at Santa Rita, N. M., on Monday, Sept. 18, an inspection will be made of the Chino Copper Co.'s mines and also of the Empire Zinc Co.'s mill, arriving at Hurley in the afternoon for inspection of Chino.

The program at Douglas, Ariz., the next day, includes visits to the reduction works of the Copper Queen and of the Calumet & Arizona companies. The first technical sessions will be held in the afternoon and evening on the subjects of smelting and leaching respectively.

Wednesday, Sept. 20, will find the party at Bisbee for an early visit to the mines of the district, to be followed in the afternoon by a technical session; subject, "Mining and Geology of the Warren District." The evening will be given over to a banquet and social evening.

Arrived at Globe the next morning, the party will visit the mines and reduction works of the Old Dominion company. The subject of the afternoon technical session will be, "Concentration and Flotation." The evening's banquet will be followed by a technical session on the subject of fine grinding.

Friday Sept. 22, will be spent in a visit to the reduction works of the International Smelting company and the concentrators of both the Miami and Inspiration companies. The technical session of the afternoon on the subject of mining and smelting will be followed by a banquet and social evening. The Ray Copper Co. will welcome members and guests who desire to visit its mine at Ray, but those taking this trip must rejoin the party at Phœnix.

Sunday, Sept. 24, is bound to be a memorable day. Arriving at the Grand Cañon of Arizona at 8 a.m., a visit will be made to the river 6,000 ft. below the level of the plateau. Leaving the Grand Cañon at 7:40 p.m. Sunday night, the return will be made via Alberquerque, Kansas City, and Chicago, reaching New York on Sept. 28.

Chile Copper Co.

The production figures of the Chile Exploration Co., which is the operating company owned by the Chile Copper Co., for the first six months of 1916, are:

PRODUCTION OF CHILE EXPLORATION CO.

1914	Lb.
January, actual	2,066,782
February, actual	3,144,480
March, actual	3,536,796
April, actual	3,702,327
May, cabled	3,664,000
June, cabled	3,610,000

In future the company will publish its production figures monthly.

Editorials

The Average Price of Copper in 1915

All the principal copper producing companies now having made their public reports for 1915, if they do so at all, it is possible to compare their average receipts for copper in that year and also make comparison with our quotational average, as in previous years. Let it be noted at the outset that 1915 was a phenomenal period, and one in which conditions were extraordinarily confused; also that many of the important producers which previously had reported both their gross price (including freight to delivery point of the refined copper, etc.) and net price, in 1915 gave only one figure without explanation, leaving it uncertain whether it stood for the gross or net. In certain cases it is possible to deduce clearly that the gross price is given, and probably that is so in most of the other cases unless the contrary be stated. Anyway, it may be accepted that the several reports in the accompanying table do not mean the same thing; also, that the difference between net and gross price in 1915 was larger than usual, owing to the greatly increased cost of delivering copper both at home and abroad, but especially the latter.

However, a more important discrepancy arises from whether the companies reported their average receipt on the basis of copper sold and delivered or on sales alone. The year was one of steadily rising prices, which by the end had advanced hugely as compared with the beginning; and moreover, the production and sales expanded in volume during the year. Indeed, during the first quarter, when copper was low, about all the companies were operating on a curtailed basis and prices were then at the lowest. As the price advanced in the second quarter, production was increased and the latter tendency continued throughout the year, and there was a large carry-over of copper produced and sold in 1915, but not delivered and paid for until 1916.

If, therefore, a producer reckoned the proceeds of his 1915 production, awaiting the returns for such of it as was delivered in 1916, he obtained the credit of a much higher figure than another producer who reported only what he had sold and delivered. For example, the North Butte company delivered 19,725,510 lb. @ 16.703c. per lb., but it sold 27,805,869 lb. @ 18.114c. With conditions as they were, the quantitative average should have exceeded the arithmethical quotational average.

The discrepancy among the returns of the several producers is explained to a large extent in the ways previously indicated. The fact that Phelps, Dodge & Co. obtained only 16.079c. does not mean that its sales department was asleep, but simply that its accountants reported only the copper that had been produced and realized. Others evidently reckoned the copper produced in 1915, but not delivered and paid for until 1916.

It cannot be deduced positively from the Hayden-Jackling reports just what their figures mean. The Utah, Nevada, Chino and Ray companies reported an aggregate of 336,350,381 lb. @ 17.524c. All this copper was sold by the American Smelting and Refining Co., which reported a production of 551,798,000 lb. valued at 16.13c. The returns of other companies selling through that agency were more in line with the latter figure than the former. In 1914 there was no such discrepancy, for the matter of carry-over does not make so great a difference when the prices over the turn of the years is not very different, as often is the case. The Hayden-Jackling companies in 1914 reported 275,938,710 lb. of copper sold at an average of 13.313c., while the American Smelting and Refining Co. reported a production of 529,686,000 lb., valued at 13.46c.

COPPER SALES IN 1915

Company	Lb.	Proceeds	Av. Price
Chino	64,887,788	$11,303,957	17.42c. (a)
Miami	41,907,754	7,262,884	17.331 (b)
Nevada Consolidated	62,726,651	11,069,671	17.647 (a)
North Butte	19,725,510	3,294,752	16.703 (c)
Phelps, Dodge & Co	194,925,668	31,342,098	16.079 (d)
Ray Consolidated	60,338,936	10,470,274	17.352 (a)
U. S. Sm., Ref. and Min	26,923,674	4,895,532	18.183 (e)
Utah Copper Co	148,397,006	26,235,331	17.679 (a)
Total	619,832,987	.....	17.299
E. & M. J. average	.....	.....	17.275

(a) Probably figured on copper produced and sold in 1915 but partly delivered and paid for in 1916. Whether gross price or net price not stated.
(b) Gross price.
(c) Produced and delivered in 1915. Whether gross price or net price not stated.
(d) Produced and delivered in 1915. Net price.
(e) Average of sales. Whether gross price or net price not stated.

PRODUCTION, SALE AND PRICE FOR COPPER FOR 11 YEARS (a)

Year	Total Production	Pounds Reported	Average Realized	Quotational Average
1905	219,000,000	82,372,955	15.597	15.699
1906	224,071,000	113,411,645	19.146	19.616
1907	220,317,041	66,316,025	18.043	20.661
1908	222,267,444	125,949,248	13.348	13.424
1909	226,602,134	136,005,773	13.221	13.335
1910	221,400,864	126,710,763	12.96	13.039
1911	216,112,867	135,329,098	12.657	12.634
1912	1,228,333,298	552,155,308	15.841	16.341
1913	1,406,448,665	658,533,402	15.222	15.269
1914	1,342,634,206	566,687,750	13.458	13.602 (b)
1915	1,411,652,418	619,832,987	17.299	17.275

(a) Up to 1912 the figures represent Lake copper production and sales, but few of the producers of electrolytic making detailed reports in that time. Beginning with 1912, the figures represent electrolytic copper only. The figures for "pounds reported" and "average realized" do not include the United Metals Selling Co. (Anaconda), which does not publish these details. However, it is a reasonable assumption that its results were not very different from those of the other companies, for John D. Ryan has stated that in the 10 years ending with 1913 his companies sold 5,560,000,000 lb. of copper at an average of 14.82c., delivered to the buyers in Europe and America. This would be equivalent to 14.62@14.67c., net cash, New York. During the same 10-year period, Phelps, Dodge & Co. reported an average of 14.56c. per lb., net cash, New York, actually realized. The arithmetical mean of the quotational averages for electrolytic copper in this period is 15.06c.
(b) Average for nine months. No quotations in August, September and October. However, the bulk of the copper sold in 1914 was disposed of before and after those months, wherefore the comparison on the nine months' basis is approximately correct.

A comparison of the production of copper, the quantity reported produced and delivered or produced and sold, the average price received and the *Journal's* quotational average—all these figures extending over a series of years—is given in an accompanying table. The quantity sold, from which the average is computed, is really larger in proportion to the production than is indicated by the table, for upward of 200,000,000 lb. annually of the A. S. & R. Co. is sold at about the same price as reported for Utah, Chino, etc., the sales of that agency being divided proportionately among the constituent producers. The largest part of the remainder of the production is represented by the Anaconda sales, the average of which is not given in the official report of that company.

The close agreement between the average realized by

eight companies in the sale of about 620,000,000 lb. of copper in 1915, as officially reported by them, and the quotational average of the *Journal* is more of a coincidence than a check, for the realization is figured on proceeds computed in different ways. Nevertheless the actual agreement was probably about as close. The average realized by the companies for their copper produced and delivered in 1915 was probably about 16.08 to 16.50c., net cash, New York. The average realized on sales was probably about 17¼c., net cash, New York.

Reverting to the discrepancy among the company reports for 1915, when it was unusually wide, it would be an improvement if all the producers would reduce their figures to a uniform basis of net price and according to a uniform system of accounting. This is desirable not only for the purpose of comparison, but also for precise knowledge of just how the companies stand. So long as things are at sixes and sevens in this particular, there is a danger of confusion about overlaps, which there would not be if things were reduced to a uniform basis.

Non-Ferrous Metallurgy

The next award of the gold medal of the Mining and Metallurgical Society of America, which will be made in January, 1917, is to be for distinguished service in the art of smelting metals other than iron. It is rather unfortunate that we have no good term for the description of that branch of metallurgy and are obliged to refer to it as "non-ferrous," smelting, or more broadly "non-ferrous" metallurgy. There is a similarity among the metallurgies of copper and lead, and even of zinc, tin and antimony. Between those metallurgies and that of iron there is a great practical difference, wherefore there is a sharp division which is indicated by the terms "ferrous" and "non-ferrous" in default of anything better.

In selecting non-ferrous smelting for its next subject the council of the Society means practically copper smelting, for two reasons, viz: (1) Copper smelting is more important industrially by far than any other kind and (2) there is no other branch of the art in which there have been major improvements save perhaps in the case of lead. In tin there has been nothing, though electrolytic refining may become a major development. In antimony the Herrenschmidt method is without doubt an improvement of outstanding character, but the metal itself is of minor importance. In zinc the names of Wetherill and Hegeler, two inventors whose work made important and lasting impressions, rise among those that deserve high honor, but both of those men are deceased and among modern zinc-smelters there is no one who has put a deep stamp on his art.

With respect to the metallurgy of lead the condition is different. The introduction and development of the process of blast-roasting by Huntington and Heberlein, Dwight and Lloyd, was one of the great improvements of all time. That process is not, however, confined to lead, being used also in connection with copper smelting, wherefore we get back to our premise that the choice of the M. & M. Society means practically copper smelting.

In copper smelting there is a wealth of great ideas and great things to weigh and appraise. It is well that the award of the M. & M. medal is not limited to members of the Society. Anybody—American or foreigner—may be chosen for the honor. It is interesting to look over the field.

The development of the great modern smelting plants, of which the Washoe was the first, was a thing of high importance inthe art. With this are associated the names of Frank Klepetko, the pioneer, and E. P. Mathewson and L. D. Ricketts. At one time pyritic smelting played a great part in the metallurgy of copper and there were several metallurgists who were eminent in it, paving the way for a process that added greatly to the wealth of the world. For a long time there was a ding-dong contest between the blast furnace (operated pyritically or semi-pyritically) and the reverberatory. The same Mathewson built furnaces of each kind of previously unparalleled proportions. The blast-roasting process overcame the fine-ore trouble and seemed likely to established the lead of the blast furnace, when coal-dust firing gave victory to the reverberatory. With the last feat the name of David H. Browne is undisputably preëminent. An accomplishment of equal importance in technology was the development of the basic copper converter with which the names of Peirce and Smith are associated. But before all of these things was that great stride—electrolytic refining.

Here we have a rich field out of which to select some metallurgist for special honor as the renderer of service that in the minds of professional men entitles him to honor above others.

What Is the Matter with the Copper Stocks

A question that is asked us as frequently as any other is, "What is the matter with the copper stocks?" It might equally well be asked "What is the matter with the railway stocks, industrial stocks and good stocks generally?" In market value all of them have failed to appreciate in comparison with the wonderful change in their financial position. Columns have been written on this subject, pointing out how many of the standard copper stocks are selling for less than they did just before the war why should this be?

The best answer to the question, we think, was given by a writer in the New York *Evening Post* last week, who said "The real, underlying factor is the fear of the investing and speculating public of the end of the war. That fear overshadows everything. Military experts may tell us that the war is going to last at least another year; the public does not know; it is not confident that the military experts know, and it is not betting its money on it. There is uncertainty both as to when the war will end and as to what will happen when it does end. We are not sure there will be a depression after the war is over, but we do not know; and the uncertainty is enough to stop buying."

Adding to this the knowledge that there has been large selling in our market of rails, industrials and coppers, which probably is still going on, and we have an adequate explanation of the failure of the stock market to respond to the improvement in corporate affairs.

People in the purlieus of Wall St., intoxicated by the huge profits that many of the industrial companies have realized, have worked themselves into the frame of mind that causes the return of peace to be regarded as a bogy. How can intelligent thought be so perverted? The return of peace would be the greatest conceivable blessing

to mankind, and to his commerce and industry. It may be followed by disastrous conditions—even the bankruptcy of Europe—and may be not; but if the former, things will be the worse the longer they be put off, and if the latter, the better they will be. The return of peace is something to be welcomed, not merely from the humanitarian standpoint but also from the economic. That it should be regarded as a bogy is nothing but the manifestation of an unhealthy growth in swinish minds.

BY THE WAY

During 1915 secondary metals were recovered from scrap, sweepings, etc., in the United States to the value of $114,304,930, according to U. S. Geological Survey.

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While not generally regarded as interested in mining, the appraisement of the estate of the late J. P. Morgan, recently published, disclosed the fact that he held at the time of his death mining securities valued at more than $1,000,000. These included $268,000 of Cerro de Pasco Mining Co. 6% debentures, valued at $192,960; 5,500 shares, Cerro de Pasco Investment Co., $550,000; 27,784 shares, Champion Reef Gold Mining Co. of India, $69,864; 4,730 shares, Mysore Gold Mining Co., $121,716; 12,000 shares, North Star Mines Co., $132,000; 20,000 shares, Stratton's Independence, Ltd., $9,745; 1,125 shares, Transvaal Gold Mining Estates, Ltd., $15,759; Mr. Morgan owned worthless stocks of a par value of more than $7,000,000; among these were shares in three mining companies, probably acquired through trade as most of them were not of a type that would have appealed to him for investment; they included 4,000 shares of ordinary and 2,857 of preferred shares of the Nine Reefs Gold Mining Co.; 30,000 shares of Candelaria Mining Co. and 100,000 shares of the Bassick Gold Mining Co. The total estate was appraised at $78,149,024 of which $18,933,951 was in stocks and bonds; a nearly equal amount in art collections in the Metropolitan Museum of Art, and about $5,000,000 was represented in his library which was his crowning achievement as a collector. It is interesting to note that his mining securities represented about 5.75% of his stock-and-bond investments, an amount much larger than would have been generally supposed.

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July Mining Dividends

Disbursements in July to stockholders by 41 United States mining companies making public reports amounted to $11,878,960, as compared with $11,052,732 in July, 1915. Iron, industrial and holding companies allied to mining paid $3,842,094 in July, 1916, as compared with $2,469,821 in 1915, while Canadian, Central American and Mexican companies paid $1,201,912 as compared with $962,129 a year ago.

The record of United States mining companies for last month is a distinct change from that of the earlier months of the year, during each of which the amounts paid were greatly in excess of the dividends of the corresponding period in 1915. The smallness of the increase here recorded is probably accounted for by the fact that last year the Anaconda company paid its quarterly dividend in July, and this year will pay it in August. Also, Goldfield Consolidated, which paid over $300,000 last year is not now on the list, and the Tennessee Copper Co. passed its regular dividend, amounting to about $150,000. Other companies which paid in July, 1915, and not in July of this year were: Interstate-Callahan ($575,000), Stewart, ($433,392) and Utah Consolidated ($150,000), as well as a few smaller ones.

The Champion dividend was paid to the Copper Range Co. and the St. Mary's Mineral Land Co., each of which owns one-half of the stock. The payment by the Engels Copper Co. was its initial dividend. The New Jersey Zinc Co. dividend was an extra of $10 per share. The Hollinger payment of 5c. a share is the first dividend on the new stock of the Hollinger Consolidated Mines Co.; the rate is the same as before, as four shares of the new stock is equivalent to one share of the old. The Republic Iron and Steel paid the regular quarterly dividend of $1.75 on its preferred stock and $2 back dividends.

United States Mining Companies	Situation	Per Share	Total
Ahmeek, c	Mich.	$3.00	$600,000
Allouez, c	Mich.	2.00	200,000
Ariz. Copper, c	Ariz.	0.36	547,162
Bunker Hill & Sullivan	Ida.	0.50	163,500
Bunker Hill Con., g	Calif.	.025	5,000
Caledonia, l.s.c	Ida.	.03	78,150
Camp Bird, pfd., g	Colo.	.17	110,565
Center Creek, l.z	Mo.	.15	15,000
Champion, c	Mich.	6.40	640,000
Continental Zinc, l.z	Mo.	1.00	22,000
Eagle & Blue Bell, g.s.l	Utah	.05	44,657
Engels Copper Co., c	Calif.	.01½	22,000
Golden Cycle, g	Colo.	.02	30,000
Hecla, l.s	Ida.	.15	150,000
Homestake, g	S. D.	.65	163,254
Inspiration, c	Ariz.	2.00	2,318,942
Iron Blossom, s.l.g	Utah	.10	100,000
Iron Cap Cop., pfd., c	Ariz.	.35	16,558
Isle Royale, c	Mich.	1.00	150,000
Joplin Ore & Spelter	Mo.	.04½	18,000
Judge Min. and Smelt., s.l	Utah	.25	120,000
Kenefick Zinc, z	Mo.	.10	20,000
Nat. Zinc & Lead, l.z	Mo.	.05	25,000
New Jersey Zinc, z	U. S.	10.00	3,500,000
North Butte, c	Mont.	.75	322,500
Osceola, c	Mich.	4.00	384,600
Pacific Mines Corpn., g	Calif.	.02	12,840
Portland, g	Colo.	.03	90,000
Prince Con., s.l	Nev.	.05	50,000
Reorg. Booth, g	Nev.	.10	100,000
Shattuck-Arizona, c	Ariz.	1.25	437,500
Silver King Coalition	Utah	.15	187,500
Silver King Con	Utah	.10	63,758
Success, s	Ida.	.03	45,000
Tonopah Belmont, s	Nev.	.12½	187,504
Tonopah Extension, s	Nev.	.15	190,920
Tonopah Mining, s	Nev.	.15	150,000
United Verde, c	Ariz.	.75	225,000
Utah Apex, c	Utah	.25	132,050
Vindicator, g	Colo.	.06	90,000
Yellow Pine, s.l.s	Nev.	.15	150,000

Iron, Metallurgical and Holding Companies	Situation	Per Share	Total
Am. Sm. Sec., pfd. A	U. S.	$1.50	$247,747
Am. Sm. Sec., pfd. B	U. S.	1.25	375,000
Bethlehem Steel, com	U. S.	7.50	1,114,650
Bethlehem Steel, pfd	U. S.	1.75	260,890
Cleveland-Cliffs Iron	U. S.	2.50	184,253
Republic Iron & Steel, pfd	U. S.	3.75	765,634
Sloss-Sheffield, pfd	U. S.	1.75	117,250
U. S. Smelting, com	U. S.	1.00	351,115
U. S. Smelting, pfd	U. S.	.87½	425,555

Canadian and Central American Companies	Situation	Per Share	Total
Butters Salvador, g	C. A.	$0.24	$37,500
Cons. Min. & Sm., g.s.c	B. C.	2.50	209,830
Hollinger, g	Ont.	.05	120,000
La Rose, s	Ont.	.05	74,931
McKinley-Darragh-Savage, s	Ont.	.03	67,431
New York & London Co., s	C. A.	.50	100,000
Nipissing	Ont.	.25	300,000
Peterson Lake, s	Ont.	.01½	42,032
Porcupine Crown, s	Ont.	.03	60,000
Standard Silver Lead, s.l	B. C.	.02½	50,000
Temiskaming, s	Ont.	.03	75,000
Tough-Oakes	Ont.	.12½	65,188

The totals for the first seven months of the year are as follows: Mining companies, $96,533,884, as against $37,053,776 in 1915; iron, metallurgical and holding companies, $58,371,259, as against $36,633,973 in 1915; Canadian, Mexican and Central American mines, $12,630,599, as against $4,497,751 in 1915. The accompanying table shows details of the month's payments.

PERSONALS

F. C. Floss has gone from Oregon to Perseverance, Alaska.

Lloyd Owen has gone from New York to Anaime, Ibaque, Colombia.

J. P. Chadwick has gone from North Waterloo, Me., to Valparaiso, Chile.

George B. Church has gone from Brooklyn, N. Y., to Salt Lake City, Utah.

George F. Bridger is now in Los Angeles, Calif., having left Pachuca, Mexico.

Shang Lung Tung, recently at Cleveland, Ohio, has gone to Shanghai, China.

George H. Nolde, lately at Wisner, Neb., is now with the Carrara Marble Mines of Nevada.

C. G. Dobson, late of Butte, has gone to British Columbia where he is at the Brittania mine, Howe Sound.

W. B. Weiler, lately at Berkeley, Calif., is now with the Boundary Red Mountain Min'ng Co. at Sardis, B. C.

William Seddon, of Brownsville, Penn., has been appointed consulting engineer for the Pioneer Coal Co. of Illinois.

E. E. Entwistle has been made mechanical engineer at the Steelton plant of the Bethlehem Steel Co. in charge of all construction.

Charles A. Mitke, ventilation expert for the Phelps Dodge Co., looked over some of the mines of the Lake Superior district recently.

John D. Ryan has been at Houghton, Mich., and will go from there to Montana, expecting to return to New York early in September.

P. A. Robbins, manger of the Hollinger Consolidated Co. in Ontario, has been elected a director and made managing director of the company.

H. P. Henderson returned to New York after an extended trip through the West and will shortly leave for Cuba, where he will remain for a few weeks.

F. S. Norcross, Jr., superintendent of the British Columbia Copper Co., went through some of the mines of the Cleveland-Cliffs Iron Co. on the Marquette range recently.

E. O. Wells, of Chattanooga, has been made superintendent of the Roane Iron Co., Rockwood, Tenn., succeeding Frederick H. Clymer, superintendent of the plant since 1907.

Ernest W. Ellis, for some years at the Washoe Reduction Works in Montana, is now superintendent of construction at a zinc plant at Edwards, St. Lawrence County, N. Y.

William F. Stein has resigned as superintendent of the crucible department of the Bethlehem Steel Co., South Bethlehem, and has been succeeded by Samuel T. Harleman.

W. H. Gould has been appointed manager of the New Idria quicksilver mine in San Benito County, California. He was recently at the Harvard gold mine in Tuolumne County.

John M. Baker and **Hamilton W. Baker** have resigned as general manager and mine superintendent respectively of the Baker Mines Co., of Oregon. Their address is now 1043 Emerson St., Denver, Colo.

Harrison A. Dunn is stil imprisoned in the City of Mexico. The latest information from the Department of State is that all of the papers in the case are before a military court and that an immediate conclusion has been ordered.

Earl McIntire, for several years civil engineer at the mills of the Republic Iron and Steel Co., Youngstown, Ohio, has resigned to take a similar position at Ojibway, Ont., at the Steel Corporation's new operation.

W. R. Hulbert, of the Goldschmidt Thermit Co., of New York, delivered an illustrated lecture, supplemented with many practical demonstrations, to the members of the Clinchfield Railway Club at Erwin, Tenn., July 25.

Louis D. Gordon, president and manager of the Cerro Gordo mine, Inyo County, Calif., and Round Mountain mine, Nevada, recently spent two weeks visiting the property, making the trip from San Francisco in a Mercer machine.

H. O. Hofman, professor of metallurgy in the Institute of Technology, Boston, was recently at San Francisco and is now at Salt Lake City. He has visited the lead smelters at Chicago, Omaha, East Helena, Northport, Trail, Selby and Tooele.

Albert T. Keller, who as chief engineer of the Indiana Steel Co., has had charge of construction work at Gary, Ind., has accepted the appointment as chief engineer of construction for the Bethlehem Steel Co., at Sparrows Point, Md., and will have charge of the extensive new work at the Maryland plant.

Charles Pascoe, former metallurgist for the Canadian Steel Foundries, Ltd., and recently connected with the Thos. Davidson Manufacturing Co., Ltd., of Montreal, as consulting metallurgist, has joined the Snyder Electric Furnace Co., Chicago, as metallurgist in that company's research plant, at Clearing, Ill.

B. M. Newcomb, of Haas Brothers, San Francisco, former manager of the New Idria quicksilver mine in San Benito County, California, recently made a visit to his old home place in Maine and also to New York, Boston and other cities in New England. The visit covered a period of five weeks and included the attention to important business matters in New York and Boston. Mr. Newcomb's recent retirement from the management of the New Idria mine was due to his inability to give sufficient personal attention to necessary improvements and developments.

OBITUARY

Cecil W. Pocock died at Edwards, N. Y., on July 19. At the time of his death Mr. Pocock was superintendent of the Northern Ore Co. in St. Lawrence County.

Llewellyn Humphreys died at Los Angeles, Calif., July 14, aged 54 years. Born in Wales he had been in this country for many years. During the last 20 years he had done a good deal of important inspecting work in the states of Utah, Nevada and Arizona.

John A. Kern, a pioneer miner and mine owner of Eldorado County, Calif., died at Placerville June 1, aged 78 years. He was born in Ohio and went to California 61 years ago. He mined on the Comstock and in other Nevada mining districts and married in 1870; his wife, sons and daughters survive him.

Franz Haniel died at Düsseldorf, Germany, in the last week of June, aged 74 years. He was one of the leading figures in the West German coal and iron industries, having been a director of the Gutehoffnungshütte, a partner in the engineering works of Haniel & Lueg, of Düsseldorf, and the ship-owning firm, Franz Haniel & Co., of Ruhrort. He was also a member of the council of the Rhenish-Westphalian Coal Syndicate.

SOCIETIES

National Association of Sheet and Tin Plate Manufacturers—This association has been formed by 24 of the loading independent mills in the country. The formation of the National Association is significant, because it absorbs the Sheet and Tin Plate Manufacturers' Association, which had existed for a number of years. All members of the old society have become identified with the new body. Officers follow: President, W. S. Horner, American Rolling Mill Co.; vice-president, Joseph B. Andrews, Newport Rolling Mill Co.; directors: W. S. Horner, W. A. Thomas, Brier Hill Steel Co.; John O. Pew, Youngstown Iron and Steel Co., Ed. Langenbach, Stark Rolling Mill Co.; G. H. Jones, Inland Steel Co.; W. H. Abbott, Wheeling Corrugating Co. The association adopted a resolution strongly favoring contracts which will contain no provision guaranteeing prices against market decline and other objectionable features. It heartily approved the plan of the American Iron and Steel Institute to submit and recommend for the adoption of the manufacturers in all lines of the iron and steel industry a new form of contract, binding the parties to respect it and carry it out.

TRADE CATALOGS

Portland Continuous Filter. Colorado Iron Works Co., Denver, Colo. Pamphlet Np. 28-B. Pp. 15, 6x9 in.; illustrated.

Traveling Water Screens. Chain Belt Co., Milwaukee, Wis. Bulletin No. 64. Pp. 8, 6x9 in. This illustrates and describes water screens designed primarily to remove refuse and foreign material from water before it enters power plants and other industrial plants requiring large quantities of clean water.

Monarch-Rockwell Double-Chamber Melting Furnaces and tilting reverberatory furnaces, core ovens, burners, blowers, etc. The Monarch Engineering & Mfg. Co., 1206 American Building, Baltimore, Md. Catalog "TMI". Pp. 28, 9x12; illustrated. This includes description of the "Steele-Harvey" crucible tilting furnaces for melting iron, steel, cyanides, ores, etc.

Editorial Correspondence

SAN FRANCISCO—July 27

Fire at the Mammoth Copper Mine in Shasta County on the night of July 25 destroyed the boarding house, warehouse and aërial tramway terminal. The fire started underneath the old aërial tramway terminal. The greatest loss was of mine stores and the warehouse. Extraction of ore was interrupted for a day because the main air line was warped and cracked by the heat. The line was repaired immediately and underground work resumed Wednesday night. New boarding house was reconstructed out of an unused bunk house and although the men are put to some inconvenience, they are as well cared for as possible. The fire was practically under control when the water supply gave out. George W. Metcalfe, manager, expressed appreciation of the men who—engaged in a strike the day before—fought the fire with great energy and courage. It was due to the service of these men that the compressor house and shops were saved. Had these been destroyed, operation of the mine would have been seriously crippled. Some men were temporarily overcome by smoke, but none seriously injured. The strike and the fire together have caused a delay of four or five shifts of underground work in the mine, but the smeltery has been in continuous operation and within a short time rebuilding and repairs of the burned property will bring conditions back to normal.

Infiltration of Water in the Oil Fields of California has been under investigation by the oil department of the State Mining Bureau. It has been found that a number of localities are in need of correction of damage from this source. One such area is in the northern portion of Buena Vista hills in Midway field, where there are two productive oil sands, with a third sand carrying a large amount of salt water lying between them. The chief oil inspector, Mr. McLaughlin, states that early operation did not clearly recognize these underground conditions, and as a result some wells have passed into or even through the water sand without landing the various strings of casing in such positions as to prevent the water from flooding the productive sands. The matter has been called to the attention of the operators involved and also the Federal receiver. The Bureau has given wide publicity to the legal requirement and the necessity of operators furnishing complete logs of their wells. The larger companies generally have complied and a number of the independents also; but the files are far from complete and the inspector has issued an order to his deputies not to approve any application to deepen, abandon, redrill or shut off water at a well unless the department has been furnished with a complete log as provided by the law of 1915.

BUTTE, MONT.—July 27

A Mine-Safety Station is to be established in Butte. Word has reached here that one of the three mine-safety stations authorized by Congress, for which an appropriation of $101,500 was made, will be established in Butte. The camp has been selected because of the great amount of mining going on in this locality and the importance of extending Government aid in that region. An all-steel rescue car for which contract will soon be let, is to be stationed here. The car will be of special design, equipped with the most modern apparatus for mine-rescue work. It will be manned by an expert crew of life savers, who when not employed at mine disasters will visit different mining camps and train miners in rescue and first-aid work. Director Manning of the U. S. Bureau of Mines is expected to arrive in Butte soon to make preliminary arrangements. He will also look into the possibilities of the establishing in Butte of one of the three mining experiment stations for which $75,000 in all was appropriated. Montana people think that Butte is the logical site for such a station and efforts are being made by mining men and corporations to induce the Government to select Butte as the place for it, probably in connection with the School of Mines.

The Big Electrolytic Zinc Refinery of the Anaconda company at Great Falls is to be put into operation on Aug. 10, according to present plans. This is nearly a month earlier than the date set for starting when ground for the new plant was broken last year. The electrolytic and roaster departments are almost finished now and within two weeks everything will be in readiness to start operations at the greatest zinc refinery in the world. It will have a capacity of 5,000,000 pounds of zinc per month and the fact that this zinc will be of the high grade and purity now in great demand will add materially to the profit in getting this new department into operation. In June there were 2,800 men all told on the payrolls at the Boston & Montana reduction department—the largest number of men that has ever been employed there at one time. The 2,000-ton concentrating plant at the Washoe Reduction Works at Anaconda is almost finished and it is planned to have it ready to operate by Aug. 5. President John D. Ryan and a large party of men prominent in the mining world are making arrangements to be present on that date and witness the starting up of the concentrator and they will go to Great Falls on Aug. 10 to watch the starting of the refinery. With the operation of both the zinc concentrator at Anaconda and the refinery at Great Falls, the zinc-producing mines of the company, which include the Poulin, Lexington, Emma, Gray Rock and Alice in Butte and the Douglas mine in Idaho, will be called upon to supply 2,000 tons of ore per day.

DENVER-July 25

Resumption of Activities in Silverton, this summer, includes most of the well-known properties. The Tucker-Ballard interests of Colorado Springs are pushing the construction of a modern mill to supplant the mill destroyed by fire some months ago at the Hamlet mine and expect it to be in operating shape soon. The old Silver Lake mill, while being somewhat remodelled to increase its capacity, is running on custom ores from the National Belle, Dora and Green Mountain mines. Otto Mears and J. H. Slattery have taken a long-time lease on the Highland Mary mine and are preparing to push new development systematically.

The Smuggler Mine, a short distance southwest of Rollinsville in Gilpin County, has been freed from litigation and purchased by Omaha men. This property was opened years ago but was never given rational exploitation until the tungsten excitement a year ago brought a group of investors into the district and they selected it and operated it as the A. K. R. mine, these letters being the initials of the purchasers. The new purchasers will immediately enlarge the mill by adding 20 new stamps to the 30 already installed. The ore is free-milling and the mine has already produced several hundred thousand dollars in gold.

At Leadville the owners of the Bartlett tunnel, on Sugar Loaf Mountain, are having a transmission line built to enable the installation of an electric-driven air compressor, it being the intention to renew the driving of this bore along the strong vein that has already produced well even under desultory operation. After it was thought the unwatering of the Fryer Hill area had been accomplished through the Harvard shaft, sinking of the shaft was abruptly postponed by the breaking out of bodies of water presumably in old stopes. At the Penrose shaft, both sinking pumps continue busy throwing approximately 2,800 gal. per min., the water probably draining from stopes somewhat remote from the shaft. Development is being pushed on several levels. Prospect Mountain, north of town, is being prospected carefully with the object of inaugurating operations at numerous points. Owing to the deep overburden covering the formations, mining men have been prevented from opening many mines although the typical Leadville series traverses the large mountain.

Marked Revival of Activity in Leadville is shown by the output of the district for the half-year just ended, during which 402,250 tons were produced, the high mark being reached in June, when 83,250 tons were mined. Production by months were approximately as follows: January 60,000 tons; February, 57,000; March, 63,000; April, 66,000; May, 73,000 and June, 83,250 tons. During these six months, 28 old mines have resumed operation. The most important at this time are: The Mikado recently taken over by George O. Argall, the Greenback owned by Patrick Mulrooney, the Harvard and Tip Top now under the control of the United States Smelting, Refining and Mining Co., the McCormick lately purchased by the Empire Zinc Co. with the Robert Emmet, and the Home Extension in the Down Town section. The others are smaller properties situated in various parts of the district, indicating the most unusual rejuvenation in the history of Leadville; several are already shipping ore. Extensive developments are planned in several sections that have long been neglected.

reaching from Iowa gulch on the south to Prospect Mountain and East Tennessee gulch on the north and including the remote areas in Twin Lakes, Half Moon, and Sugar Loaf on the west. A close canvass of the district shows 109 properties active, not including locations where yearly assessment work is now being done. The only dredge in the district, owned by the Derry Ranch Gold Dredging Co., is operating again and is obtaining a remarkable yield.

SALT LAKE CITY—July 28

Another Hydro-Electric Power Plant is being built by the Utah Power & Light Co. on the Bear River in Idaho, about 1½ mi. below the power station at Grace, which is 60 miles by river below Bear Lake. From Grace a transmission line, 135 mi. long connects with a terminal and substation 6½ mi. west from Salt Lake. This line, which at present transmits power from Grace and two other power stations operating considerably further down the river, will also carry the 11,000 hp. to be generated by the new plant. A dam is to be built across the river just below the Grace power station, and this will receive water after it passes through the Grace power house. A wooden flume—20 ft. wide by 14 ft. high, with reinforced concrete framing, and 6,000 ft. long—will deliver 1,250 sec.-ft. to the new plant. From Bear Lake the company has built a canal, which delivers water into Bear River in the dry season. To increase the efficiency of this canal, a pumping station is being installed between Bear Lake and Mud Lake. There will be five electrically driven pumps, having a combined capacity of 1,500 sec.-ft.

SPOKANE—July 26

Site of the Federal Mine Experiment Station is a subject of much discussion among mining men here and there is bitter opposition to the proposed selection of Seattle for this northwestern station. Protests have been sent from different parts of eastern Washington and practically all of Idaho and Montana to Franklin K. Lane, Secretary of the Interior, and the congressional delegations from the three states. Commercial organizations and mining associations in the different districts have joined in the protests, and the result has been that Secretary Lane has announced that Director Manning of the U. S. Bureau of Mines will be in Spokane about Aug. 6 to investigate the situation. The protests are based on the contention that Seattle is not a logical site for the station, in that it is remote from all the producing metal-mining regions of the northwest, and that if the plant is located there it will defeat the government's purpose in establishing it. Different points in the intermountain region have been suggested as a site for the experimental plant, but there is a tendency to unite on any place in the mineral region that will be satisfactory to the majority, and the fight at present is being confined to convincing Secretary Lane that Seattle should not be considered in any event. Spokane and Butte have both been suggested as more logical sites for the new station.

OATMAN, ARIZ.—July 26

The Oatman Water and Sewer Co. may relieve the Tom Reed Company of the obligation to supply water to the town of Oatman. Inasmuch as the town was the outcome of the development of the Tom Reed mine, it was natural that the company should have supplied the town with water but now that Oatman has grown beyond a one-mine town, the obligation has become a little onerous, especially as the Tom Reed now desires to use this water for its own purposes. The Arizona corporation commission, however, notified the company that it could not suddenly withdraw from this public-utility service. It appears now that a new corporation, the Oatman Water and Sewer Co. has been formed and granted permission by the corporation commission to furnish water to the townsites of Oatman, Mazona and Old Trails. The company has purchased the Lexington, Arizona and the Mazona water works systems, the old Orion pipe lines and the water production of the Big Jim and will pump water about 11 mi. from wells near the Colorado River. The wells are estimated to yield about 150,000 gal. every 24 hr. and the Big Jim will furnish about 100 gal. per min. The new company will also furnish water for the old Orion mill, which is being overhauled and modernized for the purpose of doing a custom business. Its 20 stamps are expected to be dropping in about 60 days. The mill proposes to treat ores from the Big Jim, Golconda, Arizona Tom Reed, Lexington Arizona, Boundary Cone, Paramount and the Oatman Belle. The officers of the water company are: W. H. Wise, of Los Angeles, president; V. S. Rowely, vice-president; F. F. Brush, secretary-treasurer.

JOPLIN—July 29

Restoration of Electric Service for the mines of this district was established last week by the completion of repairs to the damaged turbine at the Empire District plant at Riverton. Continued curtailment of production is threatened, however, by a shortage of water. Only slight showers have fallen in the Kansas and Missouri sections of this district since June 19, and many properties are unable to get sufficient water for mill operation. Mines at Neck City and in the West Joplin camp are down and others may have to close. In the Arkansas field the water famine is even more important as most of the mines there depend on small creeks. The Bonanza mill on Cow Creek is able to operate only half time. The Dixie Girl mill, a new plant, can get no water for operation. The Bear Hill has been down for some time on this account. The water supply for the Omeara on Boat Creek has failed.

DULUTH—July 29

Work Has Been Resumed on the Mesabi Range by about 50 per cent. of the striking miners and there are more mines operating this week. There have been a few demonstrations of late, but the remaining strikers are not taking the interest that they did. Many are holding out because they believe that the dock workers at Duluth, Two Harbors and other places will strike unless certain demands that they have made to the railroads are complied with. The dock men want higher wages, as do the crews on the lake carriers. It looks almost certain that if the raises are not granted the iron-ore business is going to suffer. The mines can get out all of the ore that is required, but if the dock men and boat hands should start trouble there would be a tie-up. The Minnesota branch of the American Federation of Labor held its meeting a few days ago and decided to give assistance to the striking miners of the Mesabi district. They stand ready to send in leaders and funds, but the Industrial Workers of the World, which started the strike, is not in favor of such a move. The men are coming to realize that they cannot hope to win out as long as they are associated with the I. W. W., as the mine operators are firm in their stand not to treat with that organization. Secretary of Labor Wilson sent two Federal investigators to the range this week, to try and bring about a settlement. They will never be successful because the companies will not send representatives to a meeting where I. W. W. leaders are in evidence. The hearing of the 14 men who are charged with murder was held in Duluth this week. Four of the men were ordered released as they did not have a hand in the affair at Biwabik. The others will have to await the action of the grand jury at Virginia.

TORONTO—July 29

International Nickel Co. has taken the first step toward the establishment of a Canadian branch by the securing of a federal charter of incorporation for the International Nickel Co. of Canada, Ltd., capitalized at $5,000,000, with head office at Toronto. As is usual in the case of large corporations, the real interests involved are not indicated, the nominal incorporators being lawyers and clerks. The establishment of the head office in Toronto leads to the inference that a site in Ontario will be selected for the plant, possibly in the Sudbury district, though representatives of the company are this week looking over sites in the Niagara district.

The Dispute Between Miners and Operators at Cobalt will be dealt with by a royal commission, which will shortly be appointed by the Canadian government. The miners have been agitating for an increase in wages, and complain that the management of the Mining Corporation of Canada, operating the Cobalt Townsite and Cobalt Lake mines, has dismissed workmen for belonging to the union. The mine operators have refused to confer with the representatives of the men, because they are affiliated with the Western Federation of Miners. Hon. T. W. Crothers, Minister of Labor, was appealed to and asked to appoint a board of investigation and conciliation under the Industrial Disputes Investigation Act. This was considered impracticable, owing to the lack of organization among the operators, as unless the latter came together for common action it would be necessary to appoint a separate board to deal with the situation in each mine. As a way out of the difficulty the appointment of a royal commission was suggested by the Minister and approved by the miners. The constitution of this body rests entirely with the government, but it is understood that they will accept suggestions as to the personnel of the commission from both parties to the dispute. No definite demands have been made on the operators, but the miners wanted a general raise of 50c. a day. When the question of higher wages first came up, the operators granted a raise of 25c. a day to all employees, and a further bonus of 25c. a day to underground workers when silver sells during the month for 70c. an ounce or over. This bonus was paid for only one month, and the employees, particularly the surface men, to whom the bonus did not apply, appear to be dissatisfied. Drill runners are now receiving $3.50 per day, and the minimum wage for surface men is $2.50. There are between 2,500 and 3,000 miners in the district and a vigorous campaign has been carried on for some time to strengthen the union, the membership of which has been increased during the last few months from 200 to over 1,000 miners.

The Mining News

ALASKA

ALASKA MEXICAN (Treadwell)—In June, mill ran 25 days, 21 hr., crushing 15,820 tons yielding $16,505, or $1.05 per ton; operating expense $24,992; operating loss, $8,486; construction $4,405.

ALASKA TREADWELL (Treadwell)—Crushed in June 78,918 tons yielding $131,730, or $1.69 per ton; operating expense, $95,894; operating profit $35,835; construction $17,392; net profit, $18,443; other income $11,200.

ALASKA UNITED (Treadwell)—In June crushed in Ready Bullion mill 24,220 tons, in 700-ft. Claim mill 20,335 tons, yielding $49,019 and $20,210 or $2.04 and $1 per ton respectively. Ready Bullion operating profit $18,725; construction $4,003; net profit, $14,721. 700-Ft. Claim operating loss $20,337; construction $6,597; net loss $26,934.

ARIZONA

Cochise County

CALUMET & ARIZONA (Warren)—Producing copper at rate of 70,000,000 lb. a year, output for first six months having been 34,875,000 lb.

COPPER QUEEN (Bisbee)—Water from Czar and Holbrook shafts, after running through the precipitating plant, will be pumped back through the upper and shallower workings, passing through old filled stopes and low-grade orebodies and ultimately through the leaching plant again.

Gila County

COUNTY ROAD being extended with force of 22 men from mouth of Russell's gulch to summit, thence down old Bob Tail road across Panadosa Copper Co.'s property to Greater Miami and the Arizona Zinc and Lead, thence to the Ray road. Will open rich mineral district.

GREATER MIAMI COPPER (Miami)—N. M. Tanner and W. L. Card making detailed examination. Contractors McGee & Sikes 75 ft. in new tunnel.

INSPIRATION (Miami)—Making preparations to add 19th and 20th units to mill; mine hoisted 19,700 tons in one day, while the mill has put through as high as 17,800 tons.

Mohave County

RAILROAD AND A WATER SYSTEM are now promised for Oatman. The water supply may be undertaken by Oatman Water and Sewer Co.; would relieve Tom Reed company of obligation to furnish town with water it needs for milling purposes.

UNITED EASTERN (Oatman)—Headframe over new No. 2 working shaft practically completed; shaft, down 375 ft., will be sunk at increased speed.

ORION (Oatman)—This company's stamp mill will be reopened as custom mill, affording an outlet for ore now being piled on the various dumps.

Pima County

AMERICAN SMELTING & REFINING (Tucson)—This company has taken lease on Morgan mine, an old producer in Twin Buttes.

LOST FRENCHMAN (Ajo)—Opened by E. H. Johnson and associates; gold quartz outcrop traceable 3,000 ft.; crosscut at 50-ft. depth has 16 ft. good ore; high-grade ore on dump.

BUSH-BAXTER (Twin Buttes)—E. G. Bush will continue development at Minnie mine, option on which was relinquished by American Smelting & Refining Co. as payment of $100,000 became due before development of another lens was accomplished.

Pinal County

TROY-ARIZONA (Troy)—Sulphide ore assaying $4.50 gold and 5% copper struck in Rattler shaft.

PINAL DEVELOPMENT (Kelvin)—Preparing to ship 6 cars of copper-gold ore from Renfro mine to Hayden smeltery; 600-cu.ft. compressor, hoist and machine drills ordered.

Yavapai County

SUNNYSIDE (Prescott)—Optioned to H. A. Groom, of Phœnix.

PITTSBURGH-JEROME (Jerome)—Main shaft down 695 ft.; building road to property.

McNULTY & McBRIDE (Prescott)—Sold 50 claims in the Copper Creek section to the Daly-Crawford-Lewisohn syndicate for approximately $300,000.

ARKANSAS AND ARIZONA (Jerome)—Unwatering resumed; W. H. Gallaghan, formerly of the Cobriza in Cochise County, is superintendent.

HOMESTEAD (Walker)—Acquired by J. J. Shockley and associates of New York; at 75-ft. depth, 3 ft. of gold ore of milling grade found in loose formation.

SHELDON MINING (Walker)—Acquired holdings of Major Mining and Milling, Stuckey Bros., Metals Milling and the Empire Mining, which will be merged into one group; John F. Pell, Newark, N. J., president.

ANGLO-SAXON SMELTING CO. (Prescott)—This company, incorporated by British interests, to build a custom smelting plant; construction to begin in December, if Federal tax on copper is not imposed. Contemplate two copper reverberatories, and one lead stack of 250-tons capacity. May erect concentrator, also.

CALIFORNIA

Amador County

KENNEDY (Jackson)—High-grade ore reported on lower levels. Tailings dam to be increased in height.

PITTS (Pine Grove)—Installation of 10-stamp mill nearing completion; was formerly at Climax mine. Bonded to M. Robinson.

CONSOLIDATED AMADOR (Sutter Creek)—Water lowered to 380-ft. point below collar and shaft repaired. Upon reaching the 600 level additional pump will be installed. Timbers found in good condition thus far, many sets requiring only renewal of one member.

CENTRAL EUREKA (Sutter Creek)—Preparations made for sinking shaft below 3,200 level. Twenty stamps are dropping and 10 more will be started in a few days; ore supply coming from lowest three levels.

SOUTH EUREKA (Sutter Creek)—Underground hoist being installed at 2,200 level of the Oneida to sink winze and carrying on development work. New hoist has capacity of 1,500 ft. Main shaft unwatered to a point within 400 ft. of sump and the ground between shaft and winze will be thoroughly explored. Twenty stamps dropping at Oneida and 80 at South Eureka. H. Malloch, of San Francisco, general manager, and William H. Schmal, superintendent.

Inyo County

KEAN WONDER (Bishop)—This old mine in Death Valley region, owned by the Frances Mohawk Co., of Goldfield, Nev., is to be reopened. Cyanide plant operating on tailings from the old mill but management decided to concentrate future work on development of new ore reserves; if results warrant new mill will be installed.

REWARD (Independence)—Reported sold to Crown Reserve Mining Co. of Montreal; work will be started on large scale soon.

TUNGSTEN MINES CO. (Bishop)—Large vein disclosed in Little Sister claim 390 ft. from portal of tunnel and 210 ft. below the collar of the shaft.

Nevada County

RED LEDGE (Nevada City)—Chrome ore being hauled to Nevada City for rail shipment to Eastern buyers. Between 300 and 800 tons of chrome ore developed.

GRASS VALLEY CONSOLIDATED (Grass Valley)—Preparing for extensive work at the Allison Ranch property. Electric pumps, hoist, compressor and power drills will be installed.

NORTH STAR (Grass Valley)—Operating mine from Central shaft which has been completely equipped. Old surface equipment of the North Star, proper, being dismantled, only foundations remain of buildings that have been in existence for 40 years. Mill is to be enlarged. Some of best ore now going to the mill is from the 6,300 level at bottom of inclined shaft. Executive and administrative operation will be from Central shaft.

Sacramento County

NATOMAS (Natoma)—Natoma No. 1 dredge which is being rebuilt has been floated and installation of machinery is in progress. Expected to be digging by October, between Fairoaks and Jura.

Siskiyou County

VICTORY (Yreka)—Mine being operated by Los Angeles men who have installed tube mill and concentrators. Hauling ore to mill with 1½-ton motor truck. Preparing also to build 700-ft. gravity tramway from tunnel mouth to the truck road. Oreshoot is 3 ft. wide. Sinking of shaft contemplated. Property situated 3 mi. from confluence of Russian Creek and Salmon River. John Nefroney, manager.

Tuolumne County

OMEGA (Jamestown)—Property on western slope of Table Mountain being prepared for resumption of mining and milling. Shaft being unwatered.

GLOBE DEVELOPMENT CO. (Chinese)—Chrome ore opened. Four cars shipped in July.

BONANZA (Sonora)—Leased to Senator J. B. Curtin and George Weston who will reopen.

SPRINGFIELD TUNNEL (Springfield)—Assessment levied to install additional drills and extend tunnel to tap gravel channel by a raise. Joseph Cademartori, superintendent.

COLORADO

Chaffee County

TURRET COPPER MINING AND REDUCTION (Turret)—Developing two copper-gold veins, one high in copper and the other in gold. F. B. Radon, superintendent.

Dolores County

ENTERPRISE (Rico)—Lessees shipping to Durango smeltery.

EMMA (Dunton)—Being developed under option by Tonopah-Belmont Development Co. Shaft being unwatered preparatory to exploring sixth level. C. S. McKenzie, superintendent.

Gilpin County

PROSPECTING IN ROLLINSVILLE DISTRICT is extending over greater area as snow recedes. On Humdinger claim, west of town, production of tungsten ore being made at high

altitude; good float found at several places well above timber line on other claims. District was gold producer, both lode and placer, before tungsten excitement started. Two principal gold mines are Perigo and Gold Dust.

San Juan County

MAYFLOWER (Silverton)—This property in Arrastre Gulch leased to Mears, Pitcher & Slattery. Work will begin at once in upper tunnel, and a 175-ft. raise will be extended from lower to upper tunnel. Wirerope tramway to connect tunnel with Mears-Wilfley mill under consideration. Body of lead-copper ore opened in upper tunnel about 200 ft. from portal; winze sunk in ore 40 ft.; vein averages 5 ft.

Teller County

GRANITE (Victor)—Dillon oreshoot exposed for 500 ft. on 1,400-ft. level; recently cut on 1,600-ft. level.

MODOC (Victor)—Shipping about 100 tons per week; developing on new 1,200 level.

ACACIA (Cripple Creek)—Shipped recently two cars, coarse and screenings, from Eagles vein of South Burns 1,200-ft. level.

ILLINOIS

FLUORSPAR PRODUCTION STOPPED since July 18 at the Rosiclare and Fairview mines owing to strike following organization in May of a local of the Western Federation of Miners and refusal of state to send militia to preserve order. Mines continued to operate until shooting of four men on July 17. These mines in southern Illinois supply most of U. S. fluorspar production, only about 1% being produced outside the Illinois-Kentucky field. Shortage at openhearth-steel plants feared. (Later—Dispatches, Aug. 1, stated nonunion men arming, would order Federation leaders to leave.)

MICHIGAN

Copper

COPPER RANGE CONSOLIDATED (Painesdale)—South levels in No. 4 Champion shaft now extend to limits of property. Further improvement being made in milling, in table recovery.

WINONA (Winona)—Slater leaching process has given good results in reducing copper content of tailings; tested in experimental plant over long period.

AHMEEK (Ahmeek)—Steel work for new No. 2 shafthouse nearly completed. Construction is not interfering with production.

MOHAWK (Mohawk)—No. 6 shaft now down below 15th level; No. 5 is below the 18th level; grade of ore from northerly shafts has not declined.

MICHIGAN COPPER MINING (Rockland)—Work is being done in Butler lode, largely in mass and "barrel" rock.

KEWEENAW (Mandan)—Trestle to mill being rushed. Milling to be started this month. All drills working in drifting; no sinking being done.

HANCOCK CONSOLIDATED (Hancock)—Shipping about 800 tons daily; more than 600 tons from Pewabic lode through No. 2 shaft, this rock being of better grade than at any previous time. Limited shipments through No. 7 Quincy include a good proportion of mass, 3- to 6-ton masses not being infrequent.

MINNESOTA

Mesabi Range

CANISTEO (Coleraine)—The Oliver company is digging drainage ditch here about ¾ mi. long and 22 ft. deep.

WALKER (Coleraine)—Ore now being removed from this pit operated by the Oliver company. Property had been idle so far this season.

CHESTER (Chisholm)—Dry house completed at this mine. Spray is used instead of basin or sink; only mine on the range employing this method; result said to be satisfactory.

CHISHOLM (Chisholm)—Tener shaft, through which ore from the Chisholm mine is now hoisted, is to be relined with concrete. Shaft is 6x18 ft., inside, and is 300 ft. deep. This is the second shaft on the Mesabi Range to be concreted. The process of relining, used last year at the Monroe mine, will be adopted.

MISSOURI

Joplin District

LUCKY JOE (Klondike)—Contemplate building mill.

AMERICAN ZINC (Granby)—Tearing down mill; will erect larger plant.

SHERIDAN (Cardin)—Will build new mill on lease near Cornfield mine.

CONSOLIDATED (Aurora)—Has drills at work and Texas pump draining lease recently acquired. Mill contemplated.

FLANNERY (Sarcoxie)—Good ore being produced from Optimo shaft, recently opened. Third Deisel engine to be installed soon.

SWEETMAN (Duenweg)—Has opened silicate mine, near old McGee mine which was district's greatest silicate producer. Has 15-ft. face at 75 ft.

HANDFORD (Joplin)—Completed draining of 30-acre lease recently acquired and 20 sub-leasing companies are at work. Handford company mining in original 40-acre lease.

Northern Arkansas

AT YELLVILLE, Mineral Belt Traction Co. has been incorporated to operate 50-passenger motor car on recently built railroad to Rush.

SUMMIT HOME (Rush)—Milling with Jeffrey pulverizer and tables. Entire outfit operated by 25-hp. gasoline engine.

CAPPS (Rush)—Gasoline motor installed to pull ore cars from mine to Morning Star mill. First used in Arkansas field.

PHILADELPHIA (Rush)—Averaging 12 to 16 tons of concentrates daily. On three successive days had turn ins of 23, 18 and 22 tons; best record ever made by any Arkansas mine.

MONTANA

Fergus County

HANOVER GYPSUM CO. (Lewistown)—This company which began operating its new gypsum plant at Hanover, 7 mi. west of Lewistown about 10 days ago, has been sold to a syndicate headed by Charles T. Boettcher, president, Denver & Salt Lake Railway Co. It will proceed at once with installation $1,000,000 cement plant to supply Montana and the Dakotas. For present D. R. Brown will act as manager.

Madison County

REVENUE CONSOLIDATED GOLD MINES (Norris)—Formed last fall to develop old mines of Richmond Flat. Force of 25 men working. Mill may be built. G. D. B. Turner, superintendent.

Silver Bow County

TUOLUMNE MINING CO. (Butte)—At the Colusa-Leonard, recently taken over by company, hoist was started July 21 for inspecting shaft and underground workings; found in good shape; as soon as unwatered, sinking will be started to 800 level. At Butte Main Range properties, retimbering in progress; shaft will be ready Sept. 1. Drift from Main Range shaft disclosed ore running as high as 8 or 9% copper. At Tuolumne mine, will explore vein below 2,600 level.

BUTTE & SUPERIOR (Butte)—Report for June shows smaller amount of ore treated in flotation plant and less concentrates recovered than in May. Tons treated in June were 48,475 and concentrates produced 10,830 tons. To decrease further the loss of zinc in tailings, company is making changes in jigs at the mill, using the system of the Timber Butte mill. At Butte & Superior mill tailings run from 0.91% to 1.1% zinc, while at Timber Butte mill loss averages only 0.45%.

NORTH BUTTE (Butte)—Recent developments encouraging. On 800 level Speculator vein is 15 ft. wide, carrying 5% copper and 2 oz. silver per ton. The Sioux Chief on 700 level averages 9.8%. The Edith May on 2,800 level shows 5.5% copper and 2 oz. silver. The North Berlin passed through fault on 2,200 level and now shows 8% copper with as high as 12 oz. silver per ton. June output amounted to 2,096,326 lb. of copper, 90,713 oz. silver and 143 oz. gold. An average of 1,500 tons of ore was hoisted daily.

NEVADA

Elko County

SURPRISE (Jarbidge)—High-grade gold ore up to 3 ft. in width struck in this property owned by J. G. Dufner.

Esmeralda County

LONE STAR (Goldfield)—Development confined to eastern portion of property; south drift from Neligan shaft is yielding encouraging assays.

SANDSTORM-KENDALL (Goldfield)—Southeast crosscut on 350-ft. level encountered vein beneath old lease workings from which rich ore was mined.

REORGANIZED CRACKER JACK (Goldfield)—Drifting north and south on 115-ft. level; south drift in low-grade quartz. Development of 300-ft. level to start soon.

JUMBO EXTENSION (Goldfield)—June profit $36,500 from 2,429 dry tons mined and 563 tons dump ore; total value $92,000. At annual meeting all officers reëlected except A. I. D'Arcy who was succeeded by Charles D. Olney as director.

ATLANTA MINES CO. (Goldfield)—West crosscut on 1,750-ft. level being driven two shifts with about 150 ft. to go to reach projection of ore mined on 1,580-ft. level Grizzley Bear ground. Arrangements made with Goldfield Consolidated to bear major portion pumping expense; water used in Consolidated mill.

Eureka County

PALISADE COPPER (Palisade)—Have opened good orebody; recent shipments ran 13% Cu. Expect to ship carload every fortnight. F. W. Smith, manager.

Lincoln County

PRINCE CONSOLIDATED (Pioche)—Company's new 200-ton concentrating plant at Bullionville is completed. Erected to treat Bullionville and Dry Valley tailings aggregate 120,000 tons. A 1-mi. spur is being constructed from the Caliente & Pioche Ry. to the Dry Valley dumps.

Nye County

TONOPAH ORE PRODUCTION for week ended July 22 was 10,139 tons valued at $208,582 compared with 10,360 tons for week previous. Producers were: Tonopah Belmont, 3,065 tons; Tonopah Mining, 2,300; Tonopah Extension, 2,200; Jim Butler, 1,300; West End, 845; Halifax, 220; Rescue-Eula, 156; North Star, 53 tons.

TONOPAH EXTENSION (Tonopah)—Receipts for June $125,754; expenses $73,594; operating profit $52,160.

KANROHAT (Round Mountain)—Property, comprising 16 claims and small mill in Jefferson Cañon, being sampled. Under option to Sprague interests of Goldfield.

JIM BUTLER (Tonopah)—At recent directors' meeting it was decided to appeal decision of Nevada Supreme Court in apex case against West End Consolidated.

TONOPAH MINING (Tonopah)—June profit $19,950 from treatment of 9,060 tons; average value $12 per ton; 119,325 oz. bullion produced, value $97,250. The 70-ft. headframe at Red Plume shaft is to be moved to the Sand Grass shaft.

WEST END (Tonopah)—At annual meeting, Oakland, Calif., directors and officers reëlected. Report for 1915 shows total operating profit of $270,416; of this amount $109,212 is profit from disputed ore and placed in escrow to await final decision of courts.

GOLD HILL NEVADA GOLD MINES CO. (Tonopah)—On this property in Lone Mountain district, shaft has been sunk 500 ft.; crosscut being driven to tap gold vein. Galena vein also outcrops. Equipped with hoist, air compressor and piston drill. May install Jackhamer. William G. Herman, superintendent. Daniel Hurton, of San Francisco, president.

Storey County

OVERMAN (Virginia)—Began general repairs underground, July 18.

HALE & NORCROSS (Virginia)—Surface tunnel now in good condition to 1,052-ft. point.

CROWN POINT-BELCHER (Gold Hill)—Work in Jacket discontinued on account of change in air conditions; overhauling electric equipment continued; 255 tons ore sent to gloryhole from shaft. Jacket mill received 319 tons mine ore and 486 tons dump rock.

UNION CONSOLIDATED (Virginia)—Extracted 363 tons; gross value over $12,000 as follows: 2,400 level, 144 tons, $62.29; 2,500 level, 41 tons, $12.75 and 177 tons, $12.62. Union shaft reopened by pumping association to 180-ft. point below 2,500 level.

MEXICAN (Virginia)—Extended 2,500 level south drift to 56-ft. point, face shows porphyry and quartz of low assay. Alterations to winze station continued on 2,700 level. Mexican mill received 362 tons custom ore averaging $34.56 and 193 tons Mexican dump rock averaging $14.12.

NEW MEXICO

Grant County

CHINO (Hurley)—Copper output in June, 7,243,618 lb.

Lincoln County

WHITE OAKS (White Oaks)—Reported that Minor S. Keith, of Boston, has taken an interest and that properties will be developed for gold, subordinating tungsten production.

Socorro County

OAKS CO. (Alma)—Developing Clifton mine; encountered good-grade milling ore in winze from adit. Shiping to Sorocco mill.

MOGOLLON MINES CO. (Mogollon)—Mill treating about 900 tons per week; new working shaft at Last Chance mine, now about 800 ft. deep. Company has inaugurated new system of freight delivery from Silver City; transfer station, including oil storage tanks, erected at Glenwood, 12 mi. from Mogollon, and fuel oil and other supplies are delivered there by truck, whence they are hauled over the heavy mountain grades to Mogollon by teams. Other operators still depending on teams or trucks for entire trip of over 80 miles.

PENNSYLVANIA

MIDVALE STEEL AND ORDNANCE CO. (Philadelphia)—Has awarded contract for 500-ton blast furnace at the Worth Brothers Co. plant at Coatesville.

SOUTH DAKOTA

Lawrence County

DEADWOOD STANDARD (Terry)—Property turned over to leasers and 100-ton mill being prepared for operation.

ECHO (Maitland)—Some 20-oz. silver ore encountered on 200-ft. level. New electric pump handling water.

CUSTER PEAK (Roubaix)—New 100-hp. boiler and compressor installed to sink shaft from 250-ft. level where orebody carrying native copper was disclosed.

ANCHOR HILL (Galena)—Bolger & Hammond are getting good results with an arrastre at this property.

RATTLESNAKE JACK (Galena)—William Sansom, of New York, won the first suit of a series which caused operations to be suspended at this mill and mine. Work will be resumed as soon as litigation is cleared.

Pennington County

COLUMBIA (Keystone)—Drifting on vein at 200 level continues with satisfactory results.

HOMELODE (Silver City)—Shaft being deepened; vein maintaining size and contents with depth.

VIRGINIA

CRIMORA MANGANESE CORPORATION (Crimora)—Mill now producing about 40 tons of washed ore daily. Company intends to increase gradually to 200-ton output.

UTAH

Beaver County

MOSCOW (Milford)—New shaft practically completed to the 1,000 level, and work of making connections with old workings will be started. Shaft will do away with unnecessary hauling and give added depth. In June shipped six cars.

Salt Lake County

UTAH COPPER (Garfield)—Production in June, 17,877,432 lb. copper.

CONGOR (Bingham)—Daily shipments of about 50 tons of copper ore from upper working, 200 ft. from surface.

MICHIGAN-UTAH (Alta)—Heavier shipments than ever before being made. Ore coming from Triangle lease in Grizzly and City Rocks workings.

OHIO COPPER MINING (Bingham)—Reorganization proposed with new $5,000,000 corporation—$2,750,000 in stock and $2,250,000 in convertible bonds. Bingham Central Ry. to be included.

SOUTH HECLA (Alta)—New strike in Kate Hays fissure opening satisfactorily. The new ore is 600 to 700 ft. from surface and 2,200 ft. or more southeast of Wedge stope, from which company has been shipping.

SILVER SHIELD (Bingham)—Conditions show improvement. Faulted ore reported by manager to have been found again in bunches in west drift of stope. Plan to sink 8-in. drill hole from surface to facilitate development of Back vein; for this work will sell 10,000 shares of treasury stock at 50c.

WASATCH MINES (Alta)—This company owning 900 acres—600 patented—will soon begin work on its 4,000-ft. tunnel to give an added depth of 300 ft. below the 400 level. Excavation for power plant completed, and machinery on ground. Two 480-cu.ft. compressors will be installed.

Summit County

NEW QUINCY (Park City)—Seventh car shipped from the recent strike in this property.

JOHN THE REVELATOR (Park City)—Funds reported to have been provided; plans to sink shaft on 10-in. vein opened 150 ft. from surface.

AMERICAN FLAG (Park City)—Mines Development Co., operating part of this property under lease, has in bins 35 tons of silver ore of good grade.

Tooele County

OPHIR DISTRICT is active. Larger shipments being made; railroad from St. John to Ophir is running two trains a day.

IN DRY CANYON DISTRICT, the Dry Cañon Consolidated, Queen of the Hills, Kearsarge and Brooklyn are producing.

OPHIR HILL (Ophir)—Some crude ore being shipped; mill treating 300 tons daily.

BULLION MINES COALITION (Stockton)—Water problem appears to have been solved by tunnel 12,800 ft. long and at face 1,800 ft. below surface; mining is being done 200 ft. below the tunnel level. Flow is 1,200 gal. per min., and a 3,000-acre ranch owned by company is being irrigated. B. F. Bauer president.

WASHINGTON

LAURIER (Laurier)—Shipments of 5 to 7% copper ore being made to Granby smeltery. Grant A. Stewart, superintendent.

NEW CRYSTAL MINING (11 Fall City Block, Spokane)—Has about 1,000 tons of $23 ore at the mine near Miles, awaiting completion of roads for hauling by auto truck to Davenport. John O'Connor, manager.

WYOMING

COLORADO FUEL AND IRON (Sunrise)—Company has been shipping copper ore from a pocket in its iron property; pocket said to be much larger than those previously encountered. Thomas Tucker, superintendent.

PLATINUM MINING AND MILLING (Holmes)—This company operating old Rambler mine has been operating 100-ton mill at full capacity for some time. Julius Thielman, president and manager.

CANADA

Ontario

SHAMROCK (Cobalt)—Six veins have been cut at the 400-ft. level.

KING EDWARD (Cobalt)—Old concentrating apparatus being removed to make room for Callow flotation system.

WEST DOME (Porcupine)—Will sink new four-compartment shaft. Diamond drilling results have been satisfactory.

MINING CORPORATION (Cobalt)—Optioned Burke claims in West Shining Tree district.

TEMISKAMING (Cobalt)—Main shaft is down 1,180 ft., will be sunk to lower contact between the diabase and Keewatin.

McKINLEY-DARRAGH (Cobalt)—New ore discovered beyond fault on 400-ft. level; may be of much importance. Vein shows about 2 in. of 2,000-oz. ore.

NIPISSING (Cobalt)—Considering flotation plant to treat cyanide tailings. On July 1, cash in bank was $1,073,966; ore and bullion on hand and in transit valued at $891,953.

McINTYRE (Porcupine)—Annual report shows ore reserves of 201,900 tons, averaging $11.12 per ton, gross value $2,247,128, as compared with $854,000 the previous year.

DOME LAKE (Porcupine)—Proposal to issue 459,688 shares to shareholders at 20c. ratified. Company owes Hudson Bay Mines, $35,653; balance will be used for mill extension. Report shows 83,600 tons; gross value $1,246,500.

WRIGHT HARGRAVES (Kirkland Lake)—This operation incorporated into a company with capital of $2,500,000 in $1 shares. There will be 1,000,000 shares in treasury, balance representing the property; will be offered to public at 50c.

MOND NICKEL (Coniston)—At London meeting profits for year reported at £322,000; 20% dividend on ordinary shares declared. Lorne Power Co., of Ontario, a subsidiary, completed its plant, providing ample power for present and future needs. Large stocks of nickel-copper matte accumulated in Great Britain to assure supply for refining plant at Clydach, Swansea, Wales, in case of interruption to ocean traffic. Additional unit added to refining plant during year. Output, however, does not equal British requirements of nickel.

MEXICO

LAUGHLIN MINING (San Javier)—This American owned mine in central Sonora kept running during recent disturbances; mill handling about 4,000 tons monthly.

CUBA

WEST INDES DEVELOPMENT CO. (25 Broad St., New York)—Will develop copper properties in Cuba and Haiti—not Hawaii, as reported last week owing to typographical error.

CHOSEN

TUNGSTEN OPERATORS in Chosen have been much affected by the drop in price; many have suspended work.

AFRICA

TRANSVAAL GOLD PRODUCTION in June was: Witwatersrand, 735,194 oz.; outside districts, 26,570 oz.; total, 761,764 oz., which is 15,917 oz. less than in May, but 6,484 oz. more than in June, 1915. For the half-year ended June 30 the total was 4,408,049 oz. in 1915, and 4,631,867 oz. in 1916; an increase of 223,818 oz. The number of negro laborers reported in the mines in June was 204,773, a decrease of 1,262 from May.

The Market Report

Metal Markets

NEW YORK—Aug. 2

Copper advanced further and held firmly, although no great amount of business was done. The renewed decline in spelter went further. Lead also declined. Neither in spelter nor lead was there any important business, the declines occurring in a dull market under the pressure to sell by producers.

Copper, Tin, Lead and Zinc

Copper—The advancing tendency that we reported last week, following the transactions at low prices on July 20, continued. In the early part of July there was an extensive readjustment of conditions, resulting especially from the overbought position of a good many domestic manufacturers. The latter found in numerous cases that they had overestimated their requirements, either through the failure of expected business to materialize, or through impossibility of maintaining their rate of output by reason of increasing inefficiency of labor. Producers were therefore requested to defer contracted deliveries until later, and commonly did so; but when that could not be arranged, the released copper was offered for resale.

Producers on their part were in an excellent statistical position, and indeed were bothered about making their deliveries owing to the same causes that affected manufacturers. They were therefore in general ready to agree to transfers of deliveries. Anyway, these readjustments, which affected the market, were apparently completed soon after the middle of July, whereupon persons who needed copper then had to pay more for it, producers being firm in view of the excellent statistical position. But little copper is available for delivery until after Oct. 1, and the major market at the present time is for October-December delivery. August and September copper is very scarce and buyers are compelled to pay premiums for it, but there is only an occasional demand for those near-by deliveries.

During the last week there were some sales for export to Italy and France, but we heard of nothing for England. London cabled that the British government is supplying consumers at £121, prompt delivery, which is equivalent to about 25.65c., c.i.f., and 24.40@24.65c. here, according to whether the cost of delivery comes to 1 or 1¼c. per lb. There was some buying by domestic consumers and in the latter part of the week, 25½c., r.t., corresponding to 25¼c., net cash, New York, was realized for October-December copper. At the close the market appeared to be firmly established at that figure, with .26c., r.t., asked for near-by copper. Sales of October-December copper at 25½c. r.t., were made in several quarters, and there is evidently a general willingness to make the market on that basis.

Copper Sheets are nominally unchanged at 37½c. per lb. for hot rolled and 38½c. for cold rolled. Copper wire is 29@30c. per lb. for carload lots at mill.

Tin—Fluctuations during the week were but trifling. Business was very quiet. There was practically no demand from consumers.

Lead—Business in this metal was of much smaller proportions than in the previous week. Producers on all hands reported a competition from one quarter that was upsetting the market. The A. S. & R. Co. maintained its price at 6.50c., New York, while most of the outside producers were sellers at 6.15@6.20c. Although they made occasional sales at about that price, in general they reported failure to consummate business on their offers. The market having been disturbed in this way, it is impossible to quote it accurately in absence of knowledge of all that may have been done privately, and probably our quotations right through the week are too high. This also explains the unusual variations between the quotations for New York and St. Louis. It is certain that August-October lead was sold in tonnage business on Aug. 1 at a price netting producers less than 5.85c., St. Louis, and 5.75c., St. Louis, was reported done, this being in meeting the sharp competition from one quarter. On the same day sales were made at 6c., St. Louis. Much depended upon the information of the buyer. On Aug. 2 small business was done by outside producers at about 6.15c., New York, in the morning, but about the middle of the afternoon the A. S. & R. Co. reduced its price to 6c., New York, and at other points correspondingly. This reduction was forced upon the A. S. & R. Co. by the competition above referred to, and was made in contradiction to its judgment of market conditions, which were not regarded as justifying the development of such a state of things as has happened. The statistical position in lead continues without any doubt to be excellent, but there appears to be an aversion on the part of producers to see any accumulation of stock.

Spelter—A fair tonnage of business was reported in the early days of the week, and after that very little. On the other hand, there was considerable pressure to sell, and the decline from the short-lived rally which began last week

DAILY PRICES OF METALS IN NEW YORK

July Aug.	Sterling Exchange	Silver, Cts. per Oz.	Copper	Tin	Lead		Zinc
			Electrolytic, Cts. per Lb.	Spot, Cts. per Lb.	New York, Cts. per Lb.	St. Louis, Cts. per Lb.	St. Louis, Cts. per Lb.
27	4.7588	63¼	24¼ @25	38¼	6.15 @6.20	5.95 @6.05	8.75 @9.25
28	4.7588	63⅛	24⅜ @25⅛	38⅛	6.15 @6 20	5.95 @6.05	8.50 @9.00
29	4.7588	63⅛	24⅛ @25⅛	38⅛	6.15 @6.20	5.95 @6.05	8.50 @9.00
31	4.7581	64¼	24⅛ @25⅛	38⅜	6.15 @6.20	5 95 @6.05	8.25 @8.75
1	4.7588	64	24⅛ @25¼	38¼	6.15 @6.20	5.75 @6.00	8.25 @8.75
2	4.7581	64	25 @25½	38¼	6.00 @6.15	5.75 @5.85	8.25 @8.75

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" (r.t.) is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are as reported by Handy & Harman and are in cents per troy ounce of silver bars 999 fine.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

July-Aug.	Silver	Copper				Tin		Lead		Zinc	
		Standard		Electrolytic							
		Spot	3 Mos.	£ per Ton	Cts. per Lb.	Spot	3 Mos.	£ per Ton	Cts. per Lb.	£ per Ton	Cts. per Lb.
27	30⅜	105	103	123	26.19	165¾	166¼	28	5.95	59	12.58
28	30 $\frac{5}{16}$	111	108	124	26.40	168	168¼	28¼	6.01	60	12.77
29	30⅜	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	30 $\frac{5}{16}$	111	108	125	26.61	168½	169¼	28½	6.07	60	12.77
1	30⅜	109	104½	125	26.61	167¼	168	28⅜	6.04	55	11.71
2	30⅜	107	104	125	26.61	167¾	168½	28⅜	6.13	50	10.65

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2,240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices, in pounds sterling per 2,240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21¼c.

continued further. There was no demand from abroad. London cabled that England has ample supply of spelter and that the government stands ready to take care of consumers. Domestic consumers were conspicuous by their absence. During the latter part of the week August-September spelter was offered at 8¾@9c., then down to 8½@8¾c., from some quarters, while other sellers offered at 8½c. On Aug. 2 a lot of 75 tons of Granby "Select" spelter was sold at auction in the New York Metal Exchange at 8½c., St. Louis, spot delivery. High-grade spelter is quoted at 15@17c., intermediate at 13@14c., high-grade brass special at 10c., and common brass special at 9@9½c., all of these being asking prices.

Other Metals

NEW YORK—Aug. 2

Aluminum—The market is quiet and a trifle easier. Business has been on a moderate scale and has been done on a basis of 58@60c. per lb. for No. 1 ingots, New York.

Antimony—Antimony was again weaker. We quote 12@12½c., with last sales reported at 12¼c. The principal interests continue to be unwilling to quote futures. It is gossiped in the trade that there are several dealers in antimony who are loaded with stocks which they are anxious to dispose of, and their position is believed to have been instrumental in depressing the market. Until these stocks are materially reduced, it is difficult to foresee a steady market.

Quicksilver—The market continued dull. We quote $77@78, New York. San Francisco reports, by telegraph, $78 per flask.

Gold, Silver and Platinum

NEW YORK—Aug. 2

Gold is coming in still and more is expected from Europe at New York.

Platinum—This market was again dull and was a little weaker. Sales were made at $58@60, which we quote as the market, although one sale was reported at $55 for a small quantity.

Silver—The tone of silver the past week has been steady to firm The China exchanges are still below London silver parity, so that the steadiness to the market comes from other sources, principally mintage orders.

Mexican Dollars in New York July 27 were quoted at 49@52c.; July 28 at 49@53c.; July 29 at 48⅞@53c. July 31 at 48⅞@53c.; Aug. 1 at 49¼@53c.; Aug. 31 at 49¼@53¼c. Pesos are rather scarce.

Zinc and Lead Ore Markets

Joplin, Mo., July 29—Quotations are as follows: Base price per 2,000 lb. ore assaying 60% zinc, $75 for premium ore, $70@60 for medium grades, down to $55 for low grade. Average for week's sales, $64.29. Calamine base price per 2,000 lb. ore assaying 40% zinc, $50@40; average for week's sales, $47.55.

Lead base price per 2,000 lb. assaying 80% lead, $70; high price, $74.15; average realized for week's sales, $69.76 per ton.

Shipments for week ended July 29 were 4,989 tons blende, 489 tons calamine and 934 tons lead ore. For year to date, 200,967 tons blende, 15,752 tons calamine and 34,575 tons lead ore. Total value, $409,170 for the week; $24,198,020 for the year to date.

Repairs on electric power were installed in midweek, permitting the operation of a few mills, but with the low stage of water still existing it is but part of a loaf. The output is now down to "before the war" level, and many mines cannot restart on the price level now being paid. The 90% increase in powder, along with heavy advances in all other supplies, makes a higher price imperative for mines now idle and some still operating under low powder contracts. The average base price of blende for the month will warrant a further decrease in the wage scale, on the sliding basis in vogue, and may permit some mines to restart in August.

Platteville, Wis., July 29—Quotations are as follows: Base price per 2,000 lb. assaying 60% zinc, $65; medium grades assaying down to 50% zinc, $58. Base price per 2,000 tons, assaying 80% lead, $71. Shipments for week 2,325 tons zinc ore, 58 tons lead ore, 154 tons sulphur ore; year to date, 69,513 tons zinc ore, 2,418 tons lead ore, 16,340 tons sulphur ore. Shipped during week to separating plants 4,757 tons zinc ore.

Report for week ended July 22, delayed in transit, showed base price for 2,000 lb. blende, 60% zinc, $60@65; lower grades down to 50%, $53. Base price for lead ore, 80% was $74. Shipments for the week 2,035 tons zinc ore, 39 tons lead ore, 290 tons sulphur ore. Shipped to separating plants, 3,030 tons zinc ore.

OTHER ORES

Manganese Ore imports into the United States in May were 74,825 tons, being 56,180 tons more than in May, 1915. For the five months ended May 31 the total receipts were 27,157 tons in 1914 and in 1915, and 174,383 tons; increase of 147,226 tons this year.

Imports at Baltimore for the week included 8,800 tons manganese ore from Brazil.

Pyrites—Imports at Baltimore for the past week included 9,631 tons pyrites from Huelva, Spain.

The domestic production of pyrite in 1915 reached a new high level, due chiefly to the unprecedented demand for the mineral in making sulphuric acid. The production was 394,124 long tons, valued at $1,674,933, an increase of 57,462 tons in quantity and of $391,587 in value compared with 1914, the United States Geological Survey reports.

Antimony Ore—It is difficult to sell this ore in view of the uncertainty in the market for the metal. It is quoted nominally at $1.25@1.50 per unit.

Tungsten Ore—There was no change in this market, wherein buyers and sellers continued as far apart as ever. One of the largest producers was bid $27.50 per unit for scheelite ore of the highest class, but refused the offer and is holding for $30. We quote the market at $27.50@30 per unit.

Charles Hardy reports: "Buyers are still exceedingly shy and having contracted during the rush time for considerable quantities feel that unless consumers come again into the market they will not be buyers for a long time to come. One of the most curious features in the tungsten position is the often-repeated expression by the buyers of the ore that they are not too anxious to see the market go down further, as every drop in the prices for tungsten is utilized by the ultimate consumer to try and cancel contracts; and as most of the works have tungsten ores contracted for at high prices, such cancelations would have been disastrous on the general market condition."

Iron Trade Review

NEW YORK—Aug. 2

The iron and steel markets show very little change. Domestic business is still quiet, but export demand is extremely active and shows no sign of decreasing.

The great fire and explosion at Black Tom Island, the New York harbor freight terminus of the Lehigh Valley and other roads, on July 30, destroyed a great number of shells and other munitions waiting for export. The loss is roughly estimated at almost $20,000,000. It is claimed that most of this will fall on the buyers, as a great deal of the steel was sold on contract f.o.b. at mills. At any rate much of the material will have to be replaced. It is not likely that there will be much salvage from the wreck.

Intensely hot weather has continued to keep down work and production at the mills, the outturn in some cases being seriously limited.

Exports from Baltimore for the week included 2,257,680 lb. pig iron, 1,191,800 lb. steel billets, 6,037,056 lb. bars, 3,429,375 lb. wire rods and wire, 1,054,965 lb. rails and ties, 596,911 lb. nails and 438,208 lb. plates, all to Great Britain; 5,708,815 lb. billets and 367,570 lb. bars to France; 1,198 tons pig iron and 5,133 tons steel billets to Italy.

Steel and Iron Exports and Imports in the United States are valued by the Department of Commerce as below for May and the 11 months from July 1 to May 31:

	May		11 Months	
	1915	1916	1914-15	1915-16
Exports.....	$26,536,612	$72,918,913	$194,131,255	$545,018,533
Imports.....	2,098,145	2,745,307	20,709,426	20,337,227
Excess, exports	$18,438,467	$70,173,606	$173,421,829	$524.681,306

The exports for the 11 months of the fiscal year were by far the largest ever reported. They show an increase of $350,887,278 over 1915, and of $312,465,814 over 1914.

PITTSBURGH—Aug. 1

The steel market continues to exhibit great strength despite the general dullness in the domestic market. Prices for all regular steel products are firmly maintained. There are irregularities in the prices of some manufactured steel products such as chain, spikes, rivets, shafting, etc., but these products had been advanced altogether out of proportion to the advances in the regular steel products from which they are made.

Exports demand continues good, but is met by a particular scarcity of bottoms just at the moment. The great strength of the unfinished steel market at this time is due almost wholly to the export demand, which absorbs everything offered for early delivery.

Quite unexpectedly the Carnegie Steel Co. this afternoon announced an advance in steel bars from 2.50 to 2.60c. Other mills are likely to follow within a short time. There was no market activity to provoke an advance at this time, but perhaps the Steel Corporation was nettled at the recent reports of bars being sold the implement makers at 2.35c. and some contract buyers at 2.50c. asking for a readjustment to 2.35c.

It is generally held in steel market circles that the situation is stronger today than was expected two or three months ago would be the case. The market has stood the summer dullness better than was expected and as increased buying can hardly be avoided in a month or two, as fall arrives, the prospects are excellent from the mill viewpoint. There is still a considerable tonnage of relatively cheap steel to be delivered and this will help to maintain consumption.

Pig Iron—The market continues very dull, so dull indeed that those who were predicting a buying movement in August, with an upturn in prices, have deferred the time until early September. The principal basis of the predictions is that steel making capacity is increasing while pig iron production cannot be increased. Additions to steel capacity this year foot up fully 2,500,000 tons, according to three separate summaries made in the trade, between a third and a half of the new construction being completed to date. Larger projects, which cannot be completed before 1917, involve about as much more, but for 1917 there will be a few more blast furnaces. There is some inquiry for foundry iron in small lots, with an occasional inquiry for the first half of 1917, on which delivery the furnaces are indisposed to quote, but no inquiry for basic, and only export inquiry for bessemer. We quote: Bessemer, $21@21.50; basic, $18@18.25; foundry and malleable, $18.25@18.50; forge, $18@18.25, f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh. W. P. Snyder & Co. compute the average price obtained on all sales of 1,000-ton lots and over in July at $21, Valley, for bessemer and $18, Valley, for basic, the same as for June. The average quoted price of foundry iron in July was $18.25, Valley.

Steel—The market for billets and sheet bars is, if anything, stiffer than a week ago. While some observers regard the quotable market at $45 for both descriptions we continue to quote bessemer at $42@43 and open-hearth at $44@45, for either billets or sheet bars. Almost any description can be sold for export, the chief point being to arrange deliveries.

FERROALLOYS

Ferrosilicon, high grade, 50%, is still quoted $83@85 per ton at furnace. There is less pressure and early deliveries can be had at about the same price. Bessemer ferrosilicon ranges from $31 for 10% up to $41 for 16% at furnace.

Spiegeleisen is in better supply and a little easier, the prices being $45@50 per ton at furnace for 20%, and $60@70 for high grade, 25 to 30%, at furnace.

Ferromanganese—Demand for prompt ferromanganese is very light and the market is a narrow one with a range of $175@200, depending on whether the seller offers the material or the buyer inquires. Contract remains at $175, and deliveries in the latter part of this year are now offered, although recently sellers were supposed to be sold up for that period.

Ferrotungsten is in more demand abroad, and makers here have had several offers for export.

Exports from Baltimore for the week included 11 tons of tungsten metal to Italy.

FOREIGN IRON

Belgian Iron Works have not ceased operation altogether according to information from German sources. Among the plants in operation—most of them with reduced forces and on short time—are the John Cockerill, Marchienne-au-Pont, La Providence, Charleroi and the Constructions Electriques.

British Exports and Imports of iron and steel six months ended June 30 are valued as below by the Board of Trade returns:

	Exports	Imports	Excess
Iron and steel	28,978,562	5,343,496 Exp.	23,635,066
Machinery, hardware, etc.	14,857,780	8,450,072 Exp.	6,407,708
Totals	43,836,342	13,793,568 Exp.	30,042,774
Totals, 1915	32,641,767	11,318,067 Exp.	21,323,700

The actual tonnage of iron and steel included in the exports was 1,448,502 in 1915 and 1,845,595 in 1916; imports, 511,012 tons in 1915, and 401,281 tons this year.

Chinese Iron Ore will be developed by Japan. An agreement for the development of the Taochung iron mine, at Taochung, Franchang-Hsien, Anhui Province, China, has been made by Japanese interests according to the "Far Eastern Review." This mine is said to contain 60,000,000 tons of ore containing 65% iron against 60% usually contained in Taya ores. Negotiations which have been carried on since 1914 with the Chinese authorities by the Sino-Japanese Industrial Development Co. have recently been concluded and the rights to work the mine have been definitely conceded.

IRON ORE

The ore movement down the Lakes is excellent, so far as the tonnage goes, and the computations as to tonnage would indicate that barring accidents there is no serious prospect of a shortage. Attention is directed to the fact, however, that on account of the pressure to utilize the full carrying capacity of the lake fleet ore is shipped that would not be selected if the shippers could choose, and this results in two things, that the average iron content of the ores shipped is lowered, and the selection as to grade may not be just what is required. It is a fact shown by statistics published in past years that in seasons of heavy ore movement the average iron content goes down while in seasons of light shipments the average is higher. There is no doubt that old stockpiles are being cleared up and everything possible is being shipped at the present time.

COKE

Coke production in the Connellsville region for the week ended July 22 is reported by the "Courier" at 413,280 net tons; shipments, 412,021 tons. Shipments of Greensburg and Upper Connellsville districts, 42,130 tons. Production has been held down by short labor and extremely hot weather.

Connellsville—The market has stiffened a shade, and $2.75 is usually quoted to consumers for spot furnace. Dealers have been able to pick up odd lots occasionally at $2.50. There is no demand on contract. Foundry coke is $3.25@3.50 for prompt or contract. The advent of new byproduct ovens is regarded with less apprehension than formerly, on the basis that the good grades of Connellsville beehive coke will find a market, being supported in price by the better prices now obtainable for coal, while the poorer makes will simply disappear. The new byproduct coke plants of the Youngstown Sheet and Tube Co. at Youngstown and Corrigan, McKinney & Co. at Cleveland, 204 ovens each, are expected to be completed and put in operation this month. Many others are to follow.

United States Exports and Imports of Fuel five months ended May 31, in long tons:

	Exports		Imports	
	1915	1916	1915	1915
Anthracite	1,371,955	1,542,860	222	4,445
Bituminous	4,427,832	6,365,998	604,337	719,287
Coke	292,151	456,202	15,900	29,445
Bunker coal	2,713,277	2,989,912	.....	.....
Total	8,805,215	11,354,972	620,459	753,177

The bunker coal or coal furnished to steamships in foreign trade is practically all bituminous. The larger part of the trade, both imports and exports, is with Canada.

Belgian Coal Production in 1915 is reported from German sources as follows, comparisons being made with 1913, as there are no figures for 1914. The statement is in metric tons:

	1913	1915	Changes
Coal mined	22,847,000	14,244,000	D. 8,603,000
Coke made	3,410,000	484,000	D. 2,926,000
Briquettes made	2,580,000	1,202,000	D. 1,378,000

Most of the mines working are on short time. Costs are heavy owing to the reduced production and to difficulties in transportation.

Chemicals

NEW YORK—July 26

The general market is quiet and heavy chemicals are dull and apathetic. Prices are fairly well maintained.

Arsenic continues in light demand, but supplies are not heavy and quotations continue about $6@6.25 per 100 lb. for both spot and futures.

Copper Sulphate—The market is little changed, with fair demand and moderate sales. Very little is being taken for export just now. Quotations are $9@10 per 100 lb. for carload lots.

Nitrate of Soda—Current sales are small and this, with reports of heavy stocks, has tended to depress the market. Quotations are $3.05@3.10 per 100 lb. for spot, while futures are offered at $3@3.05. Shipments from Chile are now being made in sailing vessels.

Sulphur—A good demand exists for this article, which, combined with high freight rates has kept up the quotations. Current prices are $35 per ton, New York, for spot, and $30 for futures.

Sulphuric Acid—There is more competition and new orders are sharply looked after. Quotations for 60% acid are still about $20 per ton.

Assessments

Company	Delinq.	Sale	Amt.
Algomah, Mich.	May 18	.....	$1.00
Cedar Creek, Ida.	July 5	Aug. 5	0.01
Challenge, Nev.	Aug. 23	Sept. 13	0.05
Clear Grit, Ida.	Aug. 7	Aug. 25	0.002
Columbus Ext., Utah	July 13	Aug. 8	0.02
Cons. Imperial, Nev.	July 18	Aug. 10	0.01
Cons. Virginia, Nev.	July 27	Aug. 17	0.05
Crackerjack, Nev.	July 3	Aug. 1	0.01
Emerald, Utah.	July 15	Aug. 11	0.00½
Four Timbers, Ida.	July 26	Aug. 26	0.002
Gold Mt. Champion, Utah	July 20	Aug. 10	0.0025
Great Bend, Nev.	Aug. 15	Sept. 20	0.01
Great Western, Nev.	July 24	Aug. 15	0.005
Hope, Calif.	July 17	Aug. 14	0.01
Hugo, Ida.	July 29	Aug. 30	0.002
Iron Spar, Ida.	July 17	Aug. 15	0.003
Jacket-C. Point-Belcher, Nev.	Aug. 14	Sept. 7	0.05
Jack Waite, Ida.	July 27	Aug. 28	0.01
Kewanas Reor., Nev.	Aug. 2	Sept. 6	0.01
Lehi Tintic, Utah	Aug. 5	Aug. 25	0.0025
Lucky Calumet, Ida.	July 20	Aug. 21	0.005
Morgan Argentine, Utah	July 15	Aug. 5	0.01
Nevada-Douglas, Nev.	July 15	Aug. 16	0.10
Nevada Zinc, Nev.	Aug. 14	Sept. 2	0.01
North Lake, Mich.	June 14	.....	1.00
Old Veteran, Ida.	July 8	Aug. 5	0.002
Ophir, Nev.	Aug. 16	Sept. 6	0.05
Rico Argentine, Colo.	Aug. 17	Sept. 2	0.01
Sierra Nevada, Nev.	July 11	Aug. 3	0.10
Silver Moon, Ida.	July 8	Aug. 3	0.005
Silver Pick, Nev.	July 5	Aug. 14	0.01
Southern Swansea, Utah	July 17	Aug. 5	0.001
Spearhead Reor., Nev.	July 3	Aug. 3	0.01
Springfield Tunnel, Calif.	Aug. 15	.....	0.05
Sunrise ,Ida.	July 27	Aug. 28	0.002
Swansea Ext., Utah	July 10	Aug. 1	0.0025
Tar Baby, Utah.	Aug. 3	Sept. 4	0.01
Tarbox, Mont.	July 25	Aug. 12	0.005
Tiberius, Ida.	July 8	Aug. 1	0.001
Tintic Central, Utah	July 12	Aug. 8	0.005
Ton. Gypsy Queen, Nev.	July 11	Aug. 15	0.01
Victoria, Utah.	July 8	Aug. 2	0.005
Wolf Mt. Copper, Utah	Aug. 2	Sept. 6	0.005

Stock Quotations

SAN FRANCISCO	Aug. 1
Name of Comp.	Bid.
Alta	.03
Andes	.09
Best & Belcher	.05
Bullion	.01
Caledonia	.40
Challenge Con.	.03
Confidence	.18
Cons. Imperial	.01
Con. Virginia	.17
Gould & Curry	.03
Hale & Norcross	.07
Jacket-Cr. Pt.	.04
Mexican	.17
Occidental	.70
Ophir	.23
Overman	.04
Savage	.06
Seg Belcher	.02
Sierra Nevada	.30
Union Con.	.67
Utah Con.	.01
Belmont	4.10
Jim Butler	.86
MacNamara	.05
Midway	.18
Mont.-Tonopah	.25
North Star	.16
Rescue Eula	.24
West End Con.	.78
Atlanta	.10
Blue Bell	.01
Booth	.13
C.O.D. Con.	.03
Comb. Frac	.06
D'field B.B.	.02
D'field Daisy	.02
Jumbo Extension	.74
Pitts.-Silver Peak	‡.12
Round Mountain	.45
Sandstorm Kendall	.04
Silver Pick	.12
Central Eureka	.09
Argo	.09
Aris. Central	.23
Big Jim	.90
Lazy Boy	.14
Oatman No. Star	.10
Tom Reed	1.55
United Eastern	3.75
United Western	.10

LONDON	July 20
Alaska Tre'dwell	£5 17s 6d
Burma Corp.	3 5 0
Cam & Motor	0 12 6
Camp Bird	0 9 6
El Oro	0 9 6
Esperanza	0 12 6
Mexico Mines	4 0 0
Nechi, pfd.	0 15 6
Oroville	0 17 9
Santa Gert'dis.	0 13 0
Tomboy	1 2 6

SALT LAKE	July 31
Name of Comp.	Bid.
Alta Con.	.25
Black Jack	.05
Colorado Mining	.16
Crown Point	.03
Daly-Judge	7.78
Emma Cop.	.54
Gold Chain	.20
Grand Central	.65
Iron Blossom	1.70
Lower Mammoth	.03
May Day	.12
Opohongo	.01
Prince Con.	1.40
Seven Troughs	.03
Silver King Coal'n	2.85
Silver King Con.	3.25
Sioux Con.	.10
Uncle Sam	.06
Yankee	.20

COLO. SPRINGS	July 31
Acacia	.03
Doctor Jack Pot	.08
Elkton Con.	.12
El Paso	.71
Findlay	.03
Gold Sovereign	.03
Golden Cycle	2.05
Granite	.57
Isabella	.17
Jack Pot	‡.05
Jerry Johnson	.03
Mary McKinney	.25
Portland	1.60
Vindicator	2.10

TORONTO	July 31
Adanac	1.50
Bailey	.07
Chambers Ferland	.17
Coniagas	4.30
La Rose	.60
Peterson Lake	.22
Right of Way	.04
Seneca Superior	.50
T. & Hudson Bay	55.00
Temiskaming	.56
Trethewey	‡.21
Wettlaufer-Lor.	.15
Dome Exten.	.35
Dome Lake	.38
Foley O'Brien	.50
Hollinger	28.00
Jupiter	.28
McIntyre	1.39
Newray	.42
Porcu. Crown	.69
Preston E. D.	.03
Vipond	.39
West Dome	.36

N. Y. EXCH.	Aug. 1
Name of Comp.	Clg.
Alaska Gold M.	17
Alaska Juneau	7
Am.Sm.&Ref.,com	93
Am. Sm. & Ref., pf.	111
Am. Sm. Sec., pf. A	92
Am. Sm. Sec., pf. B.	84
Am. Zinc	34
Am. Zinc, pf.	63
Anaconda	79
Batopilas Min.	1
Bethlehem Steel	435
Bethlehem Steel, pf.	125
Butte & Superior	68
Chile Cop.	20
Chino	47
Colo. Fuel & Iron	44
Crucible Steel	69
Dome Mines	25
Federal M. & S.	13
Federal M. & S., pf.	35
Great Nor., ore ctf.	35
Greene Cananea	46
Homestake	130
Inspiration Con.	48
International Nickel	44
Kennecott	45
Lackawanna Steel	71
Miami Copper	33
Nat'l Lead, com.	63
National Lead, pf.	113
Nev. Consol.	17
Ontario Min.	6
Quicksilver	2
Quicksilver, pf.	4
Ray Con.	22
Republic I&S, com.	47
Republic I&S, pf.	109
Sloss-Sheffield	44
Tennessee Copper	25
Utah Copper	77
U. S. Steel, com.	87
U. S. Steel, pf.	117
Va. Iron C. & C.	42

N. Y. CURB	Aug. 1
Beaver Con.	.38
Buffalo Mines	.75
Butte & N. Y.	1
Butte C. & Z.	4
Caledonia	.68
Can. Cop. Corpn.	1
Cashboy	.05
Cerro de Pasco	35
Con. Ariz. Sm.	1
Con. Coppermines	2
Con. Nev.-Utah	1/16
Crystal Cop.	1
First Nat. Cop.	4
Florence	.49
Goldfield Con.	.88
Goldfield Merger	.08
Granite	.20
Hecla Min.	5
Howe Sound	4
Jerome Verde	1 1/16
Joplin Ore & Spel.	.52
Kerr Lake	4
Magma	13
Majestic	1/16
McKinley-Dar-Sa.	.60
Mother Lode	.30
Nevada Hills	.16
N. Y. & Hond.	15
Nipissing Mines	6
Oro	.04
Ray Hercules	3
Rochester Mines	.58
St. Joseph Lead	15
Standard S. L.	1 1/16
Stewart	.21
Success	.56
Tonopah	5
Tonopah Ex.	5
Tribullion	1/16
United Zinc	6
White Knob, pf.	1
White Oaks	6
Yukon Gold	2

BOSTON EXCH	Aug. 1
Name of Comp.	Bid
Adventure	2
Ahmeek	91
Algomah	1
Allouez	58
Ariz. Com., ctfs.	8
Bonanza	.25
Butte-Ballaklava	1
Calumet & Aris.	68
Calumet & Hecla	520
Centennial	14
Copper Range	57
Daly West	2
East Butte	11
Franklin	6
Granby	80
Hancock	10
Helvetia	.25
Indiana	2
Island Cr'k, com.	45
Island Cr'k, pfd.	88
Isle Royale	25
Keweenaw	3
Lake	11
La Salle	‡1
Mason Valley	1
Mass	11
Mayflower	2
Michigan	2
Mohawk	81
New Arcadian	4
New Idria	11
North Butte	20
North Lake	1
Ojibway	1
Old Colony	1
Old Dominion	62
Osceola	79
Quincy	80
St. Mary's M. L.	68
Santa Fe	1
Shannon	7
Shattuck-Aris.	26
So. Lake	4
So. Utah	.19
Superior	13
Superior & Bost.	3
Tamarack	36
Trinity	4
Tuolumne	.30
U. S. Smelting	67
U. S. Smelt'g, pf.	50
Utah Apex	3
Utah Con.	13
Utah Metal	8
Victoria	2
Winona	4
Wolverine	47
Wyandot	1

BOSTON CURB	Aug. 1
Bingham Mines	10
Boston Ely	1
Boston & Mont.	.99
Butte & Lon'n Dev.	.66
Calaveras	4
Calumet-Corbin	.02
Chief Con.	1
Cortez	.35
Crown Reserve	.45
Davis-Daly	1
Eagle & Blue Bell	1
Houghton Copper	1
Iron Cap Cop., pf.	5
Mexican Metals	.29
Mines of America	2
Mojave Tungsten	3
Nat. Zinc & Lead	1
Nevada-Douglas	1 1/16
New Baltic	1
New Cornelia	12
Ohio Copper	.12
Oneco	.80
Raven Copper	.06
Rex Cons.	.21
Rilia	.18
United Verde Ext.	27

‡Last Quotations.

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1914	1915	1916	1914	1915	1916
January	56.572	48.855	56.775	26.553	22.731	26.960
February	57.506	48.477	56.755	26.573	22.753	26.975
March	58.067	50.241	57.935	26.788	23.708	27.597
April	58.519	50.250	64.415	26.958	23.709	30.662
May	58.175	49.915	74.269	26.704	23.570	35.477
June	56.471	49.034	65.024	25.948	23.267	31.060
July	54.678	47.519	62.940	25.219	22.597	30.000
August	54.344	47.163	.....	25.979	22.780	.....
September	53.290	48.680	.....	24.260	23.591	.....
October	50.654	49.385	.....	23.199	23.925	.....
November	49.082	51.714	.....	22.703	25.094	.....
December	49.375	54.971	.....	22.900	26.373	.....
Year	54.811	49.684	.....	25.314	23.675	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York		London			
	Electrolytic		Standard		Electrolytic	
	1915	1916	1915	1916	1915	1916
Jan.	13.641	24.008	60.756	88.083	65.719	116.167
Feb.	14.394	26.440	63.494	102.667	*	133.167
Mar.	14.787	26.310	66.152	107.714	*	136.000
April	16.811	27.895	75.096	124.319	*	137.389
May	18.506	28.625	77.600	135.457	*	152.522
June	19.477	26.601	82.574	112.432	95.333	137.455
July	18.796	23.865	76.011	95.119	91.409	125.500
Aug.	16.941	.....	68.673	.....	82.333	.....
Sept.	17.502	.....	68.915	.....	85.250	.....
Oct.	17.686	.....	72.601	.....	88.000	.....
Nov.	18.627	.....	77.744	.....	93.273	.....
Dec.	20.133	.....	80.773	.....	100.43	.....
Year	17.275	.....	72.532	.....	.....	.....

TIN

Month	New York		London	
	1915	1916	1915	1916
January	34.260	41.825	156.550	175.548
February	37.415	42.717	176.925	181.107
March	48.426	50.741	180.141	193.609
April	47.884	51.230	166.225	199.736
May	38.790	49.125	162.675	196.511
June	40.288	42.231	167.636	179.466
July	37.423	38.510	167.080	168.357
August	34.389	.....	151.440	.....
September	33.125	.....	152.625	.....
October	33.080	.....	151.554	.....
November	39.224	.....	167.670	.....
December	38.779	.....	167.000	.....
Av. year	38.590	.....	163.960	.....

LEAD

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
January	3.729	5.921	3.548	5.826	18.606	31.167
February	3.827	6.246	3.718	6.164	19.122	31.988
March	4.053	7.136	3.997	7.375	21.883	34.440
April	4.221	7.630	4.142	7.655	21.094	34.368
May	4.274	7.463	4.182	7.332	20.347	32.967
June	5.932	6.936	5.836	6.749	25.170	31.011
July	5.659	6.352	5.531	6.185	24.611	28.137
August	4.656	.....	4.520	.....	21.946	.....
September	4.610	.....	4.490	.....	23.151	.....
October	4.600	.....	4.499	.....	23.994	.....
November	5.155	.....	5.078	.....	26.278	.....
December	5.355	.....	5.266	.....	28.807	.....
Year	4.673	.....	4.567	.....	22.917	.....

SPELTER

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
Jan.	6.386	16.915	6.211	16.745	30.844	89.810
Feb.	8.436	18.420	8.255	18.260	39.819	97.762
Mar.	8.541	16.846	8.360	16.676	44.141	95.043
April	10.012	16.695	9.837	16.525	49.888	99.056
May	14.781	14.276	14.610	14.106	68.100	94.217
June	21.208	11.752	21.038	11.582	100.614	68.591
July	19.026	8.925	18.856	8.755	97.250	50.750
Aug.	12.781	.....	12.611	.....	67.786	.....
Sept.	13.440	.....	13.270	.....	67.841	.....
Oct.	12.800	.....	12.596	.....	66.536	.....
Nov.	15.962	.....	15.792	.....	88.409	.....
Dec.	15.391	.....	15.221	.....	89.400	.....
Year	13.230	.....	13.054	.....	67.553	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton. * Not reported.

PIG IRON IN PITTSBURGH

Month	Bessemer‡		Basic‡		No. 2 Foundry	
	1915	1916	1915	1916	1915	1916
January	$14.59	$21.60	$13.45	$18.78	$13.90	$19.70
February	14.55	21.16	13.45	18.93	13.90	19.51
March	14.55	21.81	13.45	19.20	13.95	19.45
April	14.55	21.65	13.45	18.95	13.95	19.45
May	14.61	21.78	13.60	19.11	13.83	19.58
June	14.70	21.95	13.67	18.95	13.77	19.34
July	14.94	21.95	13.91	18.95	13.68	19.20
August	16.01	.....	15.31	.....	14.75	.....
September	16.86	.....	15.95	.....	15.70	.....
October	16.95	.....	15.96	.....	15.80	.....
November	17 57	.....	16.47	.....	17.20	.....
December	19.97	.....	18.44	.....	18.95	.....
Year	$15.82	.....	$14.76	.....	$14.95	.....

‡As reported by W. P. Snyder & Co.

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